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PAINT and varnish PRODUCTION

Formerly PAINT and VARNISH PRODUCTION MANAGER
(Established in 1911 as The Paint & Varnish Record)

Vol. XXX **International Issue** **No. 11**

United States, *by John C. Moore* 10
England, *by B. M. Letsky* 14
Belgium, *by Roger Arzens* 19
France, *by Henri Rabaté* 21
Switzerland, *by Dr. A. V. Blom* 24
The Netherlands, *by Dr. J. Hoekstra* 28
Denmark, *by Knud Christensen* 32
Germany, *by Gerhard Zeidler* 40
Italy, *by Dr. Dante Pagani* 44
Canada, *by George Fearnley* 46
South Africa, *by J. J. Anneveldt* 49
Japan, *by Dr. Shinji Iwai* 51
Federation Convention Program 34
National Paint, Varnish and Lacquer Convention Program 35
Exhibitors at Paint Industries Show 35
Advertiser's Index 70

Published Monthly at
10 McGovern Avenue
Lancaster, Penna.
by Powell Magazines, Inc.
855 Avenue of the Americas
New York 1, New York
BRyant 9-0499

PAINT and VARNISH PRODUCTION is published monthly at 10 McGovern Ave., Lancaster, Pa., by Powell Magazines, Inc. John Powell, president; Ira P. MacNair, vice-president and treasurer; Alice L. Lynch, secretary. Entered as second-class matter, November 16, 1949, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879. Subscription rates: United States and Possessions, $3.00 a year, $5.00 for two years, $10.00 for five years. Canada, $4.00 a year. Pan American Countries, $4.00 a year. All other countries $8.00. Editorial and business office: 855 Avenue of the Americas, New York 1, N. Y. BR-9-0499.

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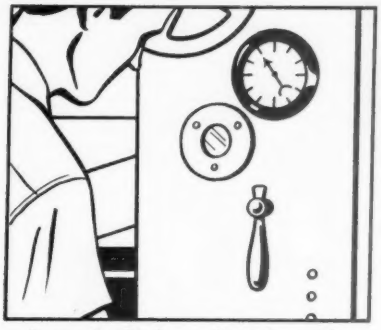

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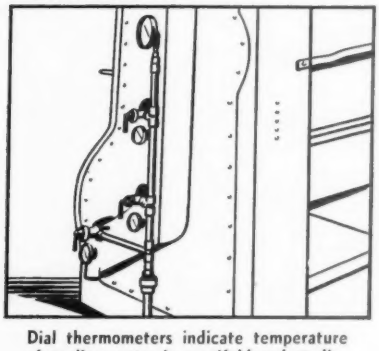

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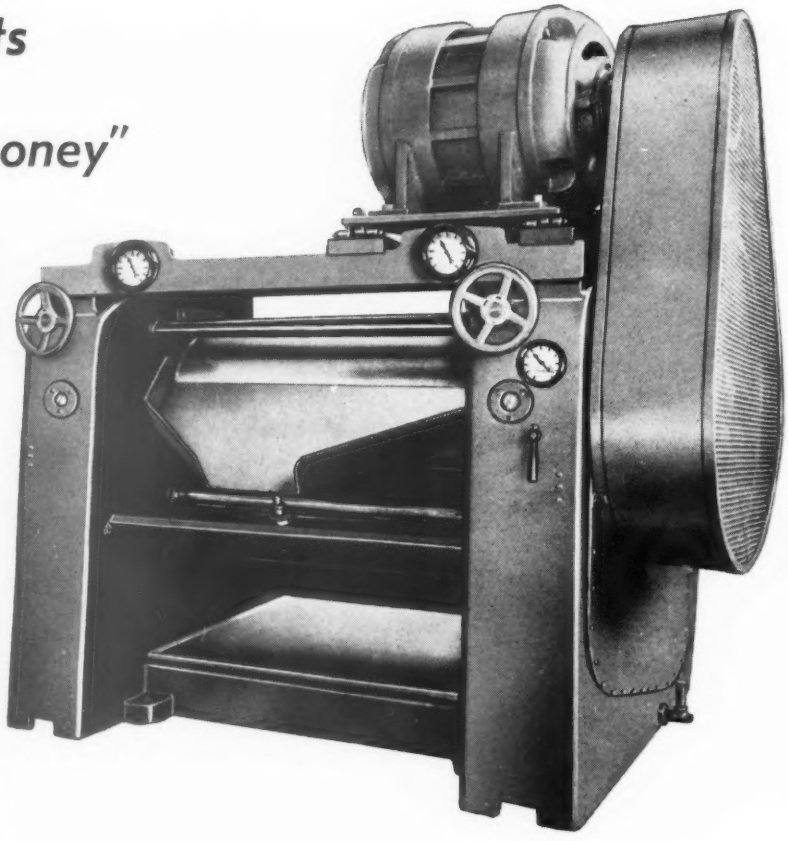

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Recently reported results of a long-term outside exposure test demonstrate again the durability of pentaerythritol rosin ester varnishes and enamels when fortified with BAKELITE Phenolic Resin BR-9400. Four test panels were coated with a single coat of white enamel, 25-gallon oil length, over WP-1 Wash Primer. Two panels carried the straight 100 per cent rosin ester coating. The other two were coated with the rosin ester vehicle modified with only 20 per cent of BR-9400.

All panels were exposed on a 45 degree test fence at Bound Brook, N. J., for 17 months. The panels coated with the BR-9400-fortified enamel showed no checking—which was apparent, however, in the other two panels. This illustrates the improvement in durability that can be obtained with the addition of a relatively small percentage of BR-9400 Resin.

...Be Ahead with BAKELITE Resin BR-4036

BAKELITE Phenolic Resin BR-4036 is particularly useful in red-lead primers for the protection of rusty steel which has long been a troublesome maintenance problem. Here is the report on a 39-month exposure test, 45-degree south, at Bloomfield, N. J. A badly rusted steel panel, cleaned only by hand wire-brushing, was given a single prime coat of a 25-gallon BR-4036, red lead, tung oil varnish. After a rapid air dry, a single gray top coat was applied and the panels were placed on roof exposure racks.

When examined more than three years later, the primer appeared at least as durable on rusty metal as red lead in oil, although formulated at an approximate saving in raw material cost of 20 per cent.

BR-4036 is useful as well in underwater primers. Primers have excellent package stability, and do not body or cake in the can for at least six months.

...Be Ahead with BAKELITE Resin BR-103

BR-103 is a 100 per cent phenolic, oil-soluble resin developed primarily for use in durable, low-cost primers, dark-colored top coats, and aluminum paints.

A recent development is a fast-drying paint in both red and black for freight cars. Vehicle is a 30-gallon BR-103 varnish containing 83 per cent tung oil and 17 per cent dehydrated castor oil plus a small quantity of raw linseed oil. Significant fact: The rapid dry permits application of two coats in one day, thereby speeding up freight car painting schedules and reducing costs.

Ready-mixed aluminum paints based on a 25-gallon BR-103 varnish have excellent package stability. The storage properties of these coatings have been demonstrated by painting two panels—one with freshly mixed paint, the other with a paint of identical formulation that had *aged for a year and three quarters!* Both panels showed complete leafing, demonstrating the outstanding storage life of BR-103 ready-mixed aluminum paints.

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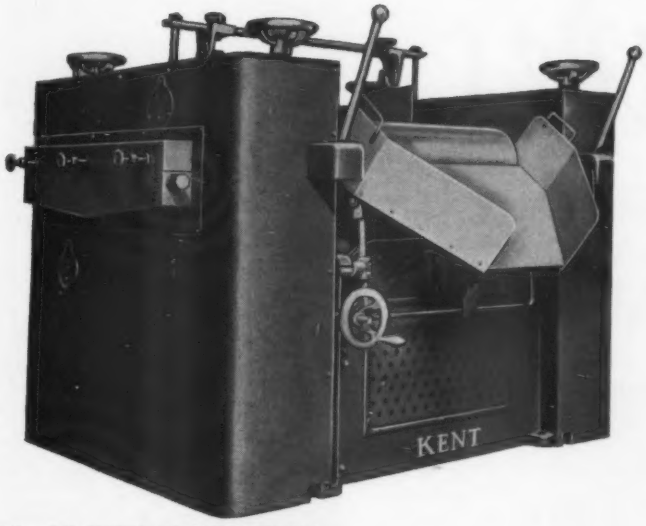

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United States

By JOHN C. MOORE,
National Paint,
Varnish and Lacquer Ass'n.

DISCUSSING such a wide subject in this limited space, prevents disclosure of some details of the improvements, and makes it necessary to mention only some of the most outstanding ones, and to give the details of a few as illustrations.

The paint industry of the United States is becoming more conscious of the importance of the proper economics in using new methods for handling materials, and for producing the desired dispersion, for instance, plants recently constructed include the most modern method of handling the incoming raw materials; the outgoing finished paints; conveyors are more prominent; the use of power-lift trucks and stackers; the pumping of liquids instead of handling them in drums, the pumping of pastes, the use of proportioning equipment, all contribute to a more efficient plant operation. The time element in mixing pastes with liquids is reduced by the use of improved mixing equipment and dispersing chemicals. The general flow of materials through the plant have been changed to include the improved machinery and methods of handling, thus resulting in better plant operation. This became necessary in most instances because of the demand for increased volume production, making it necessary to increase the efficiency of present equipment or to add materially to the general overall cost of the plant by new construction.

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Machinery and Equipment

IMPROVED dispersion means have likewise become the result of technical development. The adaptation of the "bread-mixer" idea to the dispersion of pigments in liquids is

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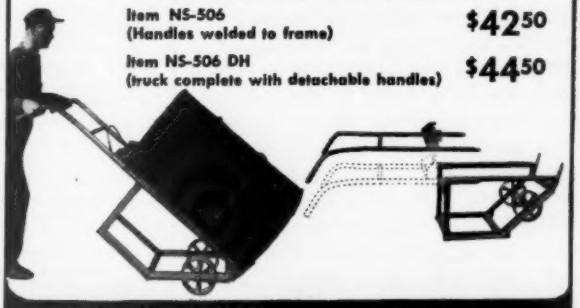

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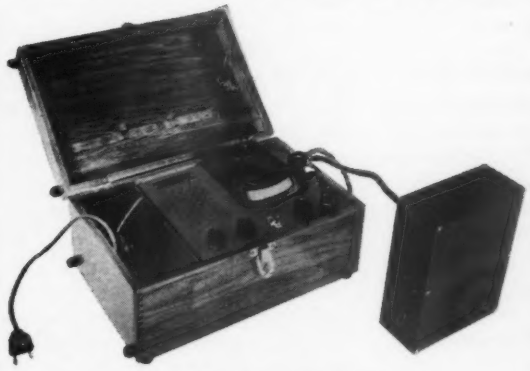

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now an accepted practice. In some instances, such equipment can be used to produce industrial type enamels. There is some work going on in an endeavor to produce a continuous process for dispersion. This is an obvious improvement and will ultimately be realized.

The size of varnish kettles was not sufficient to meet the demand for such products; this necessitated larger kettles which were hard to handle, and which were eventually mounted on permanent settings, and so we find many plants are now using the "set-kettle" for the production of larger volumes of varnishes. This has resulted in some of the plants installing their own resin kettles. The introduction of inert gases into the "set-kettles" has improved the color of the finished products.

High-speed roller mills necessitated the change in construction of the rolls; this was a metallurgical program, and while the knowledge is not new, the application to our industry enabled greater production for equipment investment.

The high-speed stone mills are being extensively used because improved stones and means of cooling have enabled the use of such high-speed equipment, leading to greater outputs and greater degree of dispersion. Improved efficiency in ball and pebble mills have been the result of much scientific investigation. Higher specific gravity grinding media and improved toughness and hardness has resulted in lowering the time of dispersion in this type of equipment. There is one improvement that has not been made, and that is the regulating of the speed of the mills by variable speed motors, or drive. Usually, the equipment comes in definite electric motor speed, and it is not possible to make speed changes which could probably lower time of dispersion.

There has been some improvement in the method of clarification, but we still use the screen method. A new approach to this problem is desirable. Some of our manufacturing costs are higher because the desired speed of clarification is not realized. Uniting the filling equipment with the clarification equipment is an improvement, as both of them are properly orientated. If more speed is desired additional equipment can be secured.

Improved methods of eliminating fumes from paint plants has occurred in recent years, but the nature and amount of these fumes are not constant and probably the best method known today is to burn them.

THE AUTHOR

John C. Moore was born in Matador, Texas, September 24, 1899, and graduated from Texas A & M College in 1922 with a B.S. in Chemical Engineering. During the next twelve years he held technical, operating and executive positions in the oil industry before taking charge of the Sinclair paint plant, where he was superintendent of the plant at Marcus Hook, Pa., from 1934 to 1947. He is well known among the technical men of the industry. He is a member, and past president of the Philadelphia Paint and Varnish Production Club, and was President of the Federation of Paint and Varnish Production Clubs in 1947; Treasurer in 1945; Vice-President in 1946. Mr. Moore is also a member of the American Chemical Society and the American Society for Testing Materials, and a Fellow of the American Institute of Chemists.

During the war, Mr. Moore was a member of the Technical Advisory Committee of the Protective Coatings Section, War Production Board, and Chairman, from 1940 to 1945, of the Federation's Technical Advisory Committee which cooperated with various branches of the Armed Services. He is now Director of the Scientific Section of the National Paint, Varnish and Lacquer Association.

Improvements in Finished Paints

ANTI-SKINNING agents are being used to improve package stability, thus delaying the oxidation of the paint. This same principle is applicable to the use of antioxidants in the dried paint film. Such compounds as copper phenolate and lead salicylate are good examples. Others are in the process of development. These can be used to extend the life of certain films.

Fire-retardant paints have always been available, but new chemicals have enabled the chemist to develop different types of fire-retardant paints which are of vital need everywhere. A method of evaluating the fire-retardant ability of such products has received wide attention, and several methods have been devised. The use of fire-retardant paints can materially contribute to the economy. It should not be claimed that they are fire-preventive; but if they can retard fire propagation until the firemen can arrive at the scene of action, they will have performed a tremendous saving.

The development of silicones has enabled producing an improved type coating to withstand high temperatures. At the present time the cost is high, but the value is great. Further use will probably lower costs but this new type of heat-resisting paint is an important factor. These silicones are finding other uses in special finishes and as anti-foaming agents.

We sometimes confuse dirt on the exterior painted surface with mildew. Technical investigations prove that mildew on paint is objectionable, not only from the viewpoint of appearance, but of durability. We continue to develop new mildewcides; some of the most outstanding are the phenyl and pyridyl mercurials, and the chlorinated phenols. We find small vials of these mildewcides available from the paint retailer for addition to paint where mildew is likely to exist.

Another outgrowth of the past War is the extensive use of preservatives; chlorinated phenols, copper, zinc and mercury naphthenates, and other similar acting products are necessary to preserve fibers of all sorts, so as to prevent rotting caused by fungi. This development is highly essential to our economy.

Analysis and Testing

ONE of the most outstanding developments of the last decade has been new analytical methods or improvements in old ones. The polarograph has allowed the use of the volumetric-gravimetric-spectrometric scheme of analysis. The electron microscope has enabled us to thoroughly investigate the raw materials used in paints. Chromatography has been useful for the separation of complex mixtures by passing them through selective adsorption media. The mass spectrophotometer is becoming more widely used, particularly for very small samples at very low pressures such as may be obtained from solvents and thinners; the use of radio-active isotopes in the study of protective coatings and their properties is a recent development.

We continue to develop new means for testing film thickness of paints applied on all types of sub-

strates. However, it is still extremely difficult to determine the thickness of paint on wood. A stroboscopic attachment to the modified Krebs-Stormer apparatus permits the speed of revolution to be controlled exactly, for determining the consistency of paint products.

Improvements in methods for evaluating adhesion has resulted in the Interchemical Adherometer, and the Arco apparatus; the ultrasonic method literally shakes the film off a cylinder, while the spinning-ball method throws the film off a sphere at very high speed of revolution.

Determining the moisture permeability of paint films has ultimately resulted in determining the vapor barrier effect of such coatings. Certain points are excellent vapor barriers and are extremely important for controlling the amount of moisture passing through an interior wall to the siding and eventually pushing off the exterior paint. We know more about the causes of paint blistering and how to prevent it. Our present home construction methods are prime contributors. Moisture from exterior or interior sources can be prevented, must be prevented or properly controlled, before final solution to the problem becomes a reality. Education of home builders and owners is essential. Recent publications are helping.

Improved antifouling paints have been developed because of a new method for determining the leaching rate of toxic materials used. Newer methods for determining the abrasion resistance of coatings has enabled the chemist to produce a better-wearing paint.

New instrument developments on the optical properties of paints, has enabled better controlled specifications for the gloss and light-reflectance of paints in general. Improved models in the accelerated weathering machines enables closer controls of the type cycles used and makes this machine a better research tool. The development of the salt-spray (fog) test enables a better study of corrosion problems.

The use of insecticides in coatings is a very important contribution and means for evaluating the effect of such insecticidal paints is new and important.

Fundamental research concerning ways for evaluating fumes and gases from burning painted surfaces, has proved that toxic gases, if any, originate with the substrate. Paint retards fire and the production of toxic gases. This work is very important as it calls specific attention to the real cause for smothering during a fire. We are paying closer attention to the type coatings applied to furniture, toys, etc.; we always have been careful about this, but improved manufacturing processes have enabled the production of what may be called "non-toxic" pigments.

Raw Materials

NEW solvents for use in producing superior finishes have resulted from the manufacture of new chemicals during the last War. They are available to us in large supply, and form the bases for sources of very important raw materials. Production of special cuts from petroleum sources has materially influenced paint formulation, as such solvents aid in making products brushable that were unsatisfactory in this respect.

The light-resistance of coatings has been a factor for some years, but the use of phthalocyanine blue has been a prime contributor to light-fast blues and greens. Improved drying oils and resins have also aided in the solution of this problem.

One important contribution to the use of paint has been the adoption of standard safety colors in industry and the utilization of special paints in schools and colleges. The combined use of light and color materially influences the educational results of our country and fundamental studies on the matter have enabled us to determine the best colors and the preferred light-reflection characteristics of paints used for this purpose. This was a result of combined research of parties interested.

The necessity for conservation of drying oils during the past war resulted in the development of coatings which have later proved superior to those existing before the war. Therefore, again, "Necessity is the Mother of Invention." Since the War, when oils are now more widely available, the majority of exterior house paints marketed, today, use less oil than was prevalent before the War, and the paints produced are of higher quality.

Improved titanium dioxide pigments where the chalking characteristics can be controlled, has enabled the paint formulator to develop "tailor-made" coatings for trade sales use. This has been a wonderful contribution to our national economy as it enables the formulator to use a variety of hiding pigments to produce superior products. There are exterior paints on the market using titanium dioxide and zinc oxide as the only hiding pigments. In this same connection, during the past decade there has been a wonderful improvement in the development of better drying oils. The use of solvent extraction has enabled the production of segregated oils and chemistry has developed a means for producing oils that can be used in place of tung oil. The use of styrene with drying oils has opened up a complete new field. Styrene was not available in large quantities at the start of this decade. The combined use of styrene and butadiene has produced a rubber-, or latex-type material that can be used in paints. Obviously the development of this material was the result of our synthetic rubber research, but paints also benefited, and they will continue to benefit as newer basic products are developed. There are paints on the market using latex as a basic ingredient. This brings up emulsion paints. They have long been with us, but the development of new emulsifying agents, as well as new chemicals, has enabled the formulator to produce superior emulsified paints. They are particularly adapted for interior paints but are finding more applications to exterior finishes as the knowledge of the art improves.

Vinyl compounds are fast finding use in special coatings. The tremendous increase in the use of these products is astonishing. Improved chemical resistance coatings are possible with these basic raw materials.

Role of the Chemist

IT is believed that the most important contribution made to the paint industry in the last decade has been realization of the importance of the chemist. It took another war to make us realize that when something is essential for our national defense, the chemist can develop it.

I vividly recall my experiences, starting in December, 1940, when the

(Turn to page 54)

By B. M. LETSKY,
A. Learner & Co., Ltd.

Houses of Parliament, looking across Parliament Square and showing Big Ben *Courtesy of British Overseas Airways*

England

IN a short contribution of this nature, it is obviously impossible to cover adequately all recent developments in the Paint and Lacquer industry, so the writer will attempt to sketch briefly some interesting features in the manufacture and application of coating products. It is important to remember that here in Great Britain we are still making up the leeway in research and technological development caused directly by World War II so that recent developments here are frequently

"cold" news in the States. The quantity and variety of raw materials from both natural and synthetic sources available here still lag far behind the United States, although on the basis of a survey made by the writer in 1948, it can be fairly stated that the technique of manufacture and also application of paint products is on a par with that of America.

Lacquer Solvents

A CASE in point is that of solvents for the paint and lacquer industry. In the States, the production of alcohol and ester solvents and diluents from petroleum sources is already on the way to rival that from fermentation of molasses or grain. In Great Britain, however, the vast bulk of our solvents (apart from toluol, xylol, white spirit etc.) come from molasses, of which there is still a world shortage, which may become worse instead of better. Therefore the completion of the new Shell Chemical Plant in Stanlow[1], near Chester, England is worthy of a little detailed attention in so far as the raw materials are of direct interest to the paint industry.

Over four years ago, the writer considered, after careful investigation, that the combination of methyl isobutyl carbinol and methyl isobutyl ketone (MIBC and MIBK) showed a number of definite advantages over that veteran pair, butyl acetate and butyl alcohol. Other factors being equal, superior flow, gloss, blush resistance and solvent power are obtained with MIBC and MIBK. It is encouraging, therefore to note that MIBK is now available in quantity and MIBC will shortly be on stream.

The basic raw material at Stanlow is gas oil and this is cracked partially so that residues and unworked gase-

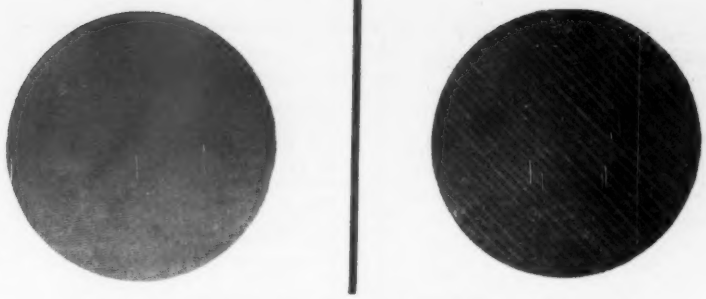


Fig. 1. Two baking finishes containing same pigment and formula except in basic urea resin. Note stirations due to pigment flocculation in the case of straight urea, see right photo.

TABLE I: SUMMARY OF PREVIOUS EXPERIENCE OF ACCELERATED AND NATURAL WEATHERING AT THE RESEARCH STATION

Paint Type.		Natural Weathering. (45° facing S.)		Accelerated Weathering.	
		Time in Months to Cause :		Time in Hours to Cause :	
Vehicle.	Pigment.	Chalking.	Checking and Cracking.	Chalking.	Checking and Cracking.
Linseed oil	White lead	9–12	9–12 (Micro.)	500	500 (Slight)
Linseed stand oil	Zinc oxide	24–36	6–9	1000	1000
Linseed oil	Red iron oxide	—	—	—	—
Bitumen	Nil	—	1–7 (According to season)	—	24
Linseed oil/phenolic resin varnish : 1½/1	Zinc oxide	1½	3–6	100	—
Linseed oil/phenolic resin varnish : 1½/1	Zinc oxide/titanium dioxide	1½	9	100	—
Linseed oil/phenolic resin varnish : 1½/1	Titanium dioxide/white lead	1½	—	250	—
Linseed oil/phenolic resin varnish : 1½/1	Lithopone/Brunswick green	—	3–9	1600	1200
Linseed oil/phenolic resin varnish: 1½/1	White lead/lithopone	3	9	—	800
Linseed oil/phenolic resin varnish : 2½/1	White lead/antimony oxide/titanium dioxide	6	9	—	2000
Linseed oil/phenolic resin varnish : 2½/1	Antimony oxide/Brunswick green	—	6	—	2000
Linseed oil/phenolic resin varnish : 3/1	Titanium dioxide/white lead	1½	9	250	2000
Tung oil/phenolic resin varnish : 3/1	Lithopone / Brunswick green	—	3–9	—	1600
Tung oil/ester gum varnish : 2½/1	Zinc oxide/titanium dioxide	—	9–12	200	—
Oiticica oil/phenolic resin varnish : 2½/1	Zinc oxide/titanium dioxide	—	2	220	500
Dehydrated castor oil/phenolic resin varnish : 2½/1	Zinc oxide/titanium dioxide	5–6	10–12	100–200	600–1300
Tung oil/rosin varnish : 2½/1	Antimony oxide/titanium dioxide	12–18	9–15	300–500	—
Tung oil/rosin varnish : 2½/1	Brunswick green	—	18–24	—	—
Linseed oil/copal varnish : 4/1	Antimony oxide/titanium dioxide	12	12–18	300–500	—
Linseed oil/copal varnish : 2½/1	Antimony oxide/titanium dioxide	8	6	100–200	500 (Micro.)
Tung oil / linseed oil / maleic resin varnish : 3/1	Zinc oxide/titanium dioxide	3	3–4	200	1000
Tung oil / linseed oil / maleic resin varnish : 3/1	Zinc oxide/titanium dioxide/antimony oxide	3	6–8	200	1000
Maleic resin/alkyd	Zinc oxide/titanium dioxide	6	6	200	1000
Maleic resin/alkyd	Zinc oxide/titanium dioxide/antimony oxide	6	8	200	1000
Rosin / ethyl cellulose : 20/1	Titanium dioxide	1½	3	50	1000
Dammar / ethyl cellulose : 20/1	Titanium dioxide	1½	3	50	1000

New Shell Chemical Plant, Stanlow, England.

ous fractions provide adequate fuel for the whole plant. Cracking takes place at high temperature and low pressure (1) in the vapor phase. The fraction up to 190° C. is used as the source of chemicals and solvents and the heavy residue as fuel oil. The light fraction is further separated by absorption and fractional distillation into fuel gas and C_3, C_4, and C_5 cuts together with a distillate rich in benzene and toluene. Further separation is effected by compression of gasses to 600 lbs/sq. in., dehydration in Lectrodriers and removal of H_2S by diethanolamine in a Girbotol unit.

Further fractionation produces n. propylene and butenes as the main product. Before these can be used for solvent manufacture, all butadiene and isobutylenes must be removed. This is effected by extractive distillation using an extractive solvent for butadiene followed by treatment with cold 60–70% sulphuric acid which absorbs the isobutylene. From normal propylene and butylene are obtained only secondary and tertiary alcohols by hydrolysis of the sulphuric alkyl esters followed by steam distillation. This is because the OH group attaches itself to the carbon atom with the least number of hydrogen atoms.

Acetone and methyl ethyl ketone are obtained by catalytic dehydrogenation of the alcohols at high temperatures in the vapor phase.

THE AUTHOR

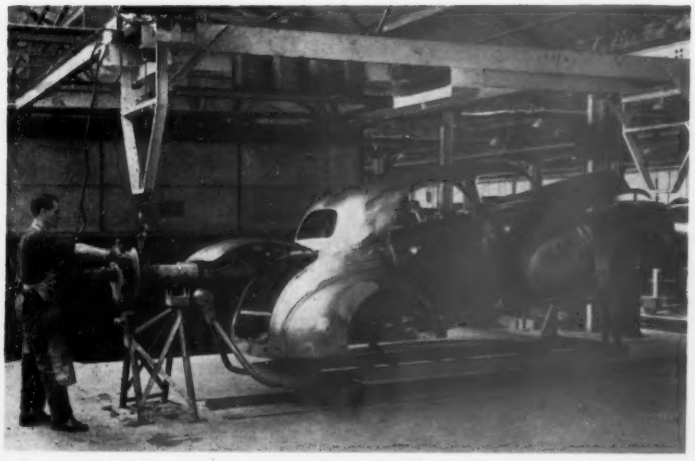
B. M. Letsky received his education at Rutherford College and Kings College, Newcastle-on-Tyne and was graduated in 1927 with honors. From 1927–1931 he was employed as Chief Chemist for Elders Walker & Co., Paint & Glass Manufacturers. In 1931 he was awarded the Master of Science degree for his work on fats and the structure of shellac. Mr. Letsky became Chief Chemist and Plant Manager of Commercial Lead Ltd. and joined the A. Learner & Co., Ltd. (Ault Wiborg Group) two years later. At the present time, he is managing director of this firm and during the last ten years has specialized in the application of organic coatings in the finishing field plus carrying on publicity and administration duties. Mr. Letsky was awarded the F. R. I. C. degree in 1948 for his work on developing a new process for manufacturing white lead and for his research work on abietic acid.

Diacetone alcohol is obtained by condensation of the acetone at low temperature. Dehydration of diacetone alcohol gives the very important mesityl oxide from which are obtained finally by successive stages of controlled hydrogenation MIBK and MIBC. The hydrogen obtained from the dehydrogenation of the alcohols is quite pure and can be used in the later stages for the hydrogenation of mesityl oxide.

The economic outcome of the development of these two main sources of solvents and chemicals (i.e. mineral or vegetable), will be of extreme interest in the near future. Today, due to absolute expansion of the finishing industries, there has been no serious rivalry. Solvents from petroleum sources have compensated for world shortage of molasses. It may be however, that greater yelds from petroleum sources will give this a temporary advantage in costs of production and variety of products obtainable. Nevertheless, one simple and fundamental fact should never be forgotten, that vegetable sources are continually renewed by Nature, while mineral resources are consumed irrecoverably and lead to ultimate exhaustion of the World's reserves.

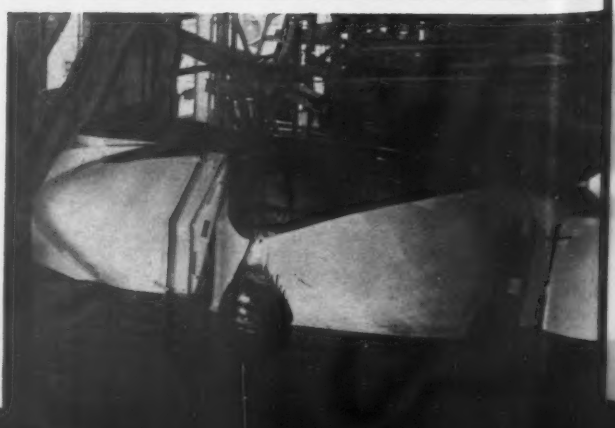
Resins

THE above considerations also apply when the question of natural vs. synthetic resins and natural versus synthetic drying oils is examined. There's no doubt that the expansion in the finishing industries has meant that these sources have supplemented



The first operation. The body is being mounted on a revolving spit prior to its journey through the Roto-dip plant process.

Body undergoing alkali cleaning operation.



Close up of a body going through primer tank in the Roto-dip.

Figure 2

rather than rivalled each other. Without the vast expansion in production of synthetic resins, the consumption of natural and fossil resins would have far exceeded Nature's speed of replacement, particularly hard Congo and Kauri gums.

In Great Britain, greatest consumption of synthetic resins is mainly long, medium and short oil alkyds with a considerable amount of phenolics for special industrial uses, i.e. in the food canning industries etc. But urea alkyd combinations, melamines, and even straight urea-formaldehyde resins are also being increasedly used for specialized purposes. The consumption of silicones is small for actual heat resisting purposes due to their high cost, but very interesting surface phenomena have been obtained by blending very small amounts with alkyds and urea alkyds, which will undoubtedly widen the scope of their use.

The problem of more accurately controlled polymerization and intensive investigation of the mechanism of the various stages has also been a feature of development work. More and more resins are now being manufactured in the presence of a solvent which is usually xylol or possibly a blend of xylol and butyl alcohol. Control is more certain, than when fusing the basic raw materials together, and the final products are often improved in color.

Paralac 6001 is an example of the above tendency. It is an unmodified urea formaldehyde produced in xylol-butyl alcohol with one remarkable advantage over previous straight U.F. resins. This is well illustrated in the photographs of two blue baking finishes. See Figure 1. Color and formula were similar except in the basic resin. Both were dipped and stoved for 30 minutes at 120° C. The "silking" or striations due to pigment flocculation is clearly brought out in the panel finished wth the older type urea resin. These photographs were taken through red filter at 3½ diameters magnification only.

Linseed oil, dehydrated castor oil, and tung oil are still the mainstay of the oil modified alkyds. Resin manufacturers have not the same facilities for switching oils in Great Britain as occur in the States. Nevertheless, during the last year or so increasing use is being made of cottonseed oil to give excellent resins, particularly for wood finishes and allied uses. With the introduction of close fractioning methods, more fatty acids in comparative purity will be available for "tailor made" resins in the near future.

In general there has been a steady advance in the quantity and quality of synthetic resins available to the paint manufacturers and from an empirical point of view the progress has been encouraging.

Polymerization Theories

IT cannot be said, however, that our fundamental knowledge of polymerization, condensation and oxidation of drying oils has kept pace wth technological advances. It is a very chastening thought that although drying oils have been used as protective mediums since that grand old monk of the eleventh century, Theophilus, wrote voluminously about the manufacture of, glue, teompara (white of egg), and oil mediums for paint, yet our knowledge of the drying process is still sketchy and largely speculative.

We do know that oxygen plays an essential part, that peroxides (estimated by potassium iodide) of still undefined structure, are formed in increasing quantity, until immediately before gelation. We do know that compounds easly oxidized like hydroquinone, can act as inhibitors of the drying process. There our knowledge ends and our inferences by analogy begin. The work of *Gomberg* on the fission of hexaphenyl ethane into free non-ionic radicals Ph_3C— and later work on the analagous decomposition of benzoyl peroxide into phenyl and benzoate radicals when in solution in benzene, has given rise to the free radical concept as a basis for vinyl polymerizations. While by no means an established fact, this concept has proved a useful tool for the understanding of straight forward polymerization like polystyrene etc. As soon as we attempt to apply the analogy to drying oils we are up against two very serious difficulties which make the ground much more insecure. First, although benzoyl peroxide is an almost universal catalyst for all vinyl polymerizations, it is of little practical value as a drying agent in unsaturated vegetable oils. Secondly, although oxygen can inhibit vinyl polymerization by the formation of stable (comparatively) oxygen complexes, there is no known case in which oxygen inhibits the drying of a drying oil. It is apparent, therefore, that there are real differences between vinyl and drying oil polymerizations and that solid foundations for a true perspective can only be achieved by actual isolation of the peroxides and their fission products. It is the instability of the peroxide complexes which makes this difficult to achieve and it is interesting to note that there appears to be an inverse correlation between the amount of peroxide complexes formed and the water resistance and durability of the dried film. This is confirmed in the work of *Slansky* which proves that by lowering the partial pressure of oxygen during the drying of linseed oil films, the water resistance is increased. More fundamental research is needed on this problem and any results achieved would certainly pay dividends on the technical side.

Pigments

IN the pigment field there is one interesting newcomer with attractive possibilities. This was obtained by a logical follow up of the acidic as well as the basic properties of lead. As is well known, red lead, usually written Pb_3O_4 is more accurately represented as lead ortho plumbate $2PbO \cdot PbO_2$.

An examination of the alkali ortho plumbates has indicated that calcium plumbate $2CaO \cdot PbO_2$ and variations to lead calcium plumbate, $PbO \cdot CaO \cdot PbO_2$ can be prepared as a valuable rust inhibitor in all colors from white to dark reddish buff. Manufacture is by fusion of lime with litharge in the requisite molecular proportions, the optimum temperature being at 700° C, when the absorption of oxygen is extremely rapid. The results of tests are very promising indeed. Four years outside exposure has so far shown no checking or cracking. Adhesion to newly galvanized surfaces after weathering, the paint film shows marked superiority to red lead. It is claimed and the experimental proof is substantial that protection and rust inhibition is cathodic as well as anodic resistance to sea water and to accelerated weathering and salt spray tests are all outstanding. The best vehicle is polymerized drying oil; such paints have been stored for two years without deterioration. Such paints cover 900–1,000 feet per gallon and opacity is good.

There is still a shortage of titanium dioxide and particularly of the Rutiox grades which have become very quickly popular when the substantial advantages in opacity and weathering properties over anatase were realized.

Sturphorizing Resins

SEVERAL manufacturers, at the present moment, are attempting to evaluate the possibilities of "Sturphorizing resins". It is claimed for these resins, that phosphating and priming are obtained in one process only. It is further claimed that adhesion, durability etc. are fully equal to that obtained by consecutive processes of phosphating and priming using the most reputable methods and materials. In view of the almost universal approval of phosphate coatings in Great Britain and America, such claims are important and could possibly and profoundly modify a large section of industrial finish manufacture and application.

From the general nature of the phosphate process it is apparent that the problem of phosphating and priming in one operation is not an easy one. Most metallic phosphates (except the alkali phosphates) are insoluble in water, but soluble in dilute and strong mineral acids. This factor is the essential basis of the phosphate process. In general, such processes depend on the dissociation of acid phosphates in water into ortho phosphates and free phosphoric acid with a general equation of the type:-

$$3M(H_2PO_4)_2 \rightleftharpoons M_3(PO_4)_2 + 4H_3PO_4$$

As long as the concentration of phosphoric acid remains above the critical point, the tertiary phosphate remains in solution and is perfectly stable. Reduction of acidity at the metal liquid interface (as when metal articles are immersed in a bonderizing solution) causes simultaneous dissolution of the metal (and formaton of the appropriate phosphate) together with precipitation of the tertiary phosphates already in solution. In the case of iron or steel the general equation would be:-

$$6Fe + 3M(H_2Po_4)_2 \rightleftharpoons M_3(PO_4)_2 + 2Fe_3(PO_4)_2 + 6H_2$$

It is obvious therefore that the rate of attack (and hence the speed of phosphating) is largely dependent on the concentration of H^+. Applied to the sturphorizing resin this means that a minimum amount of water is essential to obtain an amount of dissociation to give a reasonable rate of formation of phosphate coating, commensurate with the speed of polymerization of the resin itself.

This is achieved in the sturphorizing resin by supplying as a stable hydrophyllic colloid in a ternary solvent mixture containing up to 10% of water. The resin is phenol aldehyde type. The acid phosphates of cadmium and maganese which are incorporated, serve the dual purpose of accelerating agent of polymerization of the resin, and phosphating agent for the metal.

There are several disadvantages inherent in the use of a resin solution of the above type which must be carefully measured against the advantage of a one coat process. First it will be necessary to incorporate expensive solvents of the water-tolerant type, such as ethyl lactate, butyl cellosolve, cyclohexanone, diacetone alcohol etc. as against the much cheaper toluol, or naphthas for normal type resins. Secondly, the baking schedule at 320° F. for 45 minutes is not so economic as can be obtained with melamines or even oil modified urea alkyds. Finally, a careful investigation of the following points would be essential before the process could be authoritatively recommended:

1. Is the phosphate coating formed during sturphorizing, better than equal to, or inferior to, say, a normal Bonderized coating?

2. Is the adhesion of a sturphorized coating comparable to a high quality phenolic or alkyd, over a standard phosphate coating?

3. How does the weather resistance and general durability compare with standard coatings as above?

4. How does the overall cost per unit or area compare with that for normal Bonderizing and priming?

Subject to the above conditions being satisfied, sturphorizing resins and their development, should be a valuable addition to the rapidly growing family of protective coatings.

Testing

IN the field of testing, a complete treatise could be devoted to the numerous modified and simplified instruments for the evaluation of color, gloss, covering, adhesion, hardness, flexibility and durability. It is only proposed however, to touch on an important facet of accelerated weathering equipment in this country.

Reviewing progress since 1930 onwards, some very interesting features emerge. Despite the fact that basically similar equipment has been used by the *Paint Research Association* and reputable manufacturers since this time, there has been little correlation between the type of breakdown under natural weathering and that under accelerated conditions.[3] It is true of course, that reasonable agreement has been achieved between overall times of complete breakdown, but nevertheless, it would be hazardous, on the basis of only accelerated weathering to predict the progress and type of degradation towards the end point. Speaking very generally, intense chalking on pale shades (and some darker ones) occurs under accelerated weathering and is not parallelled by that occurring under natural conditions. On the other hand, checking, flaking and cracking through the paint film, occurs much earlier in outside exposure than under accelerated conditions.

In other words it would be unsound practice to attempt to correct any specific defect in a paint film, which occurred under accelerated weathering only.

For example, it would be pointless to correct a formulation which chalked under accelerated weathering, as this defect might not occur in the time limit required under outside exposure. This question of correlation can only be bound up with the relative intensity of the various factors producing degradation of the paint film. These can only be,

1. Water treatment.
2. Ultra violet exposure.
3. Temperature limits of exposure.
4. Chemical effects of atmosphere (oxygen, nitrogen, CO_2.).

This lack of correlation can clearly be noted in Table I in which twenty-six different types of medium with

(Turn to page 54)

Belgium

EVALUATION OF DRYING

By ROGER ARZENS,
La Chimie des Peintures

Port de Namur in Brussels *Courtesy Belgian Gov. Inf. Center*

NO matter how you consider the formation of organic coatings, you must imagine some transformation starting immediately after the application of the coating. This transformation from a more or less liquid state into a continuous solid film is usually called drying and when testing a paint or a varnish, one of the most important properties to be evaluated is the drying time.

Unfortunately, the drying process of a coating is most of the time a complicated one and generally speaking no actual scientific accuracy can be expected. It is well known among technicians of the paint industry that evaluating the drying time of a coating in the present state of our knowledge is only comparative.

It is not our intention to deal here with the scientific study of the drying process, but, nevertheless, we would like to throw some light on this particular phenomenon by trying to investigate what one can observe in practice and by devising the necessary help to make the observation as objective as possible.

In doing so, we do not deny at all the interest of scientific studies on this matter and we do not point out any particular instrument or any definitions, which might now be in use. We only like to give our own experience on the question of practical evaluation of the drying.

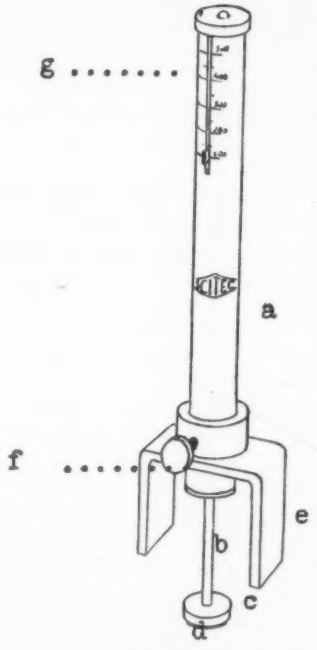


Figure 1

Definition

WE should start out by saying that the drying process is in fact the succession of infinite intermediate states. We should then put forward the idea that if we could determine among them a few characteristic states and give them a reasonable definition, we could probably have a better insight on the whole story.

Let us now take a rather simple example, a 4 hour varnish. Let us apply it on a steel plate and see what is going on. After a few minutes, we see that if we touch the varnished surface lightly with the finger tip, the varnish, which is still in the liquid state is marked by our finger, but this mark flows out well in the beginning. As time goes on, this flow proceeds with more and more difficulty, and after a certain time the finger mark remains permanent. The varnished surface has reached a state where it can no longer be equalized. The practical man says the varnish is set. It has taken 9 minutes to reach that state.

If we still touch the varnished surface, we no longer deal with a "liquid coat" but with a more viscous and rather sticky material. The pressure of our finger must be increased in order to mark it. At the same time, we notice that even fine dust adheres to the surface. Then, we come to a point where this same dust does not adhere any longer by blowing on it very lightly. The varnished surface has become dust free. It has taken 21 minutes to reach that state.

The varnish coat (we cannot yet speak of a film in the actual sense of the word) is still sticky, but again as more time elapses, the harder we must press our finger to notice a certain tack. Until we reach the point where our finger does not stick anymore to the varnish we can say the surface has become tack free. It has taken 3 hours longer to reach this state.

Film Considerations

F of some solid superficial film, but some solid superficial film, but we can easily see that the transformation is not developed throughout the coat, the underlying part still remains viscous (1). This underlying part of the coat solidifies slowly to the extent that the solid state is completed throughout, and this is now considered a whole film. If we twist the finger on the surface applying at the same time a greater pressure, we see that the film is not damaged—the varnished article is now ready for packing; it is solid throughout, taking 12 hours longer to reach this state.

Let us resume our observation and see what is now going to happen to our varnished plate. We see that our finger tip has no more action on the film. There is now another phenomenon taking place and as a result of it, the hardness of the film is increased. We find it more difficult to scratch the surface with our nail. After some time the film is hard. We must include this state in our investigation because it is in close correlation to the drying phenomenon we are studying.

It must be said, however, that the hardness of the film is not a constant one, its value, measured with any reliable method (Sward, Persoz, Rossmann, etc . . .) increases to a maximum after which the film slowly loses most of its properties up to the time of its failure. Thus, we must make a compromise, and in this particular case let us consider the hardness after 24 hours. If we agree with this conventional point, it takes 8 more hours for the film to reach this state.

Summarizing our observations, the following data was recorded:

State 1—Set after 9 minutes.

State 2—Dust free after 21 minutes longer, 30 min. from the beginning.

THE AUTHOR

Roger Arzens was born in Bordeaux, France in 1900 and studied at the University of Rennes where he obtained the Chemical Engineering degree in 1923. After a short period of metallurgical work, he became chief chemist of the International Harvester Company factories in France.

In 1928 he accepted a position with the L.C.H. Company in Villeparisis and this was his first experience with the paint industry. Mr. Arzens then became technical director of the Valentine Company plant in Brussels, and in 1938 founded the publication "La Chimie des Peintures." He also acted as a consultant for the Pieter Schoen & Zoon factories at Zaandam, Holland. He played an important part in the establishment of the Belgium Association of Technicians of the Paint and Allied Industries at Brussels whose activities were officially registered in 1945. He was the first president of this association.

In 1947 Mr. Arzens visited the United States and took part in the Paint convention held in Atlantic City.

State 3—Tack free after 3 hours longer, 3½ hours from the beginning.

State 4—Solid after 12 hours, 15½ hours after the beginning.

State 5—Hard after 8 hours longer, 23¼ hours from the beginning.

Dry State

WE have not yet used the word "dry" because we consider drying as the whole process and there is no reason in our definition that the qualification "dry" should be used at state 2 or 3 instead of 5.

It is usually used by state 3 and the name of the varnish (4 hour varnish) shows it sufficiently. We named state 3 tack free, and if the word dry should be used before state 5, we should like it better if it were used by state 4 than by state 3. But our preference goes to state 5 where the film is really beginning its normal life. This matter is open for discussion and is by no means settled.

There is also much to say about the method of observation, and it will be noticed that we have specified nothing. Our approach is more or less non-scientific.

We can very easily make some improvements in order to obtain a more objective evaluation. Thus we can specify the surface to be coated such as glass. We can specify the film thickness by using a device such as Bird Applicator. We can specify the surroundings such as constant temperature, and humidity, light and ventilation. We can then specify the manner we are going to determine the States 1, 2, 3, 4, and 5.

Method of Determination

IN the method we are now going to describe, we have tried to give the observer a finger whereby the important factors such as contact area, nature of the contact area, pressure, angle of application would be constant. This resulted in the designing of a small apparatus which we named "siccomètre" (Siccometer) (2), (see fig. 1).

It consists essentially of a dynamometer (a) the moving column (b) of which bears a disc, (c) with an insert of rubber, (d) of exactly 1 cm^2. The dynamometer is held in a special device (e), by an adjusting screw (f).

The Siccometer is held vertically and the disc brought in contact with the horizontal surface together with the two arms of the holder. The screw is then adjusted to the point where a given pressure, (say 300 grams), is applied (see the scale g).

This aparatus is used to determine the state 3 and with a special adjustment can be used to determine the state 4.

For determining states 1 and 2 we still use an empirical method which however gives good results.

At state 5 (conventional) we measuse the hardness by means of the Sward Rocker or the Persoz Pendulum.

Laboratory Methods

1—The whole test must be performed in the room at constant temperature and humidity (note both of them).

2—The coating is applied on a glass plate by means of a Bird Applicator or similar device. Note the time.

3—Twist together a few cotton fibers so as to provide for a very soft pencil which will be drawn on the surface at given intervals, (say 1 minute). Watch the mark disappear. When it is permanent, note the time; this is considered as state 1.

4—Drop at given intervals (say 5 minutes and later 1 minute) a few

(Turn to page 59)

France

By HENRI RABATÉ,
Peintures, Pigments, Vernis

Courtesy of the French Embassy Information Div.

L'Arc de Triomphe, Paris

THIS paper is concerned with a review of French scientific and industrial developments in the field of pigments, varnishes and paints, and related products during 1940 to 1950. We must view this period in two different lights, one covering the period between 1940 and 1944 and the other period since the Liberation.

Between 1940–1944 there was constant pressure brought on us by both German occupation and regulations. The scarcity of most of the essential raw materials such as drying oils made it impossible for France to produce numerous pre-war paints. The introduction of substitutes allowed only a limited amount of production. However, there were certain stocks which were kept from the Germans and held only for special application and for future use.

On the other hand, the technical men of the paint industry kept themselves busy during this period. They studied and planned the reconstruction of French paint industry so that after the Liberation there would be no loss in time in commencing production. Thus, factories which were destroyed or partially destroyed by bombing would be ready to operate as efficiently as it was possible.

Since 1945 France has been undergoing a reconstruction period. Controlled economy and export difficulties have caused an abnormal high price for important raw materials, especially linseed oil. *The National Federation of Paint, Varnish and Printing Ink Manufacturers* have repeatedly brought this matter to the attention of the responsible administrative service in an effort to have the price of linseed oil brought to a unprohibitive figure.

This article was translated by Dr. Max Kronstein of New York University.

Scientific Developments

The laboratory for paint and varnish research is located at Bellevue near Paris. Its operation is under the control of the National Federation of Manufacturers of Paints, Varnishes and Printing Inks. The Director is *Monsieur Georges Champtier,* who is a well-known specialist in the field of high polymers. Recently, he has been invited to give a series of lectures at various American Universities. He is assisted by *M. J. Petit,* whose work on the Chemistry of Drying Oils and especially Bodied Oils has gained international recognition.

Numerous projects have been under way in our laboratories which indicate that considerable attention is being devoted to the technical aspects in the field of paint and varnish. There have appeared in *"Penture—Pigments—Vernis"* many reports on the work carried out in our laboratories. Georges Champtier and his co-workers have been steady contributors to this technical paint magazine.

Besides the above organization, research is also carried on in the laboratories of the Institute of Pin, which is part of the Science Faculty of the University of Bordeaux. Here *Professor Georges Brus,* Dean of the Science Faculty and *M. Foucounau* in charge of the courses at the University, and *Monsieur Legendte,* Technical Director of the Pin Institute are working together in the field of resin research. They receive financial assistance from the French Resin Industry.

During the last year our research laboratories did some very important work in the field of resin improvement and manufacture. They are:

1. Treatment of rosin and rosin derivatives with sulfurous acid, resulting in an increase in the melting point by 25–30%, improvement in color, and improvement in stability.
2. Color improvement of asphaltic materials.
3. Purification of fatty acids by acidification.
4. New procedure for the preparation of dextro-pimaric acid.
5. Copolymerization of fatty acid with vinyl chloride.

Our laboratories have also devoted much time in studying such fundamental concepts as the chemical constitution of resinous materials. Polarimetry, Roman Spectroscopy, Ultra-violet and Infrared Spectroscopy, X-Ray Determinations, Application of Diffusions and Electrochemical Methods in determining molecular weights, and determination of forces connected with wetting and spreading have all been given considerable attention.

Interesting work in the field of direct application is constantly going on. These involve the listing of available raw materials, investigating the possibility of using complex substances as coating raw materials.

Other laboratories conducting research and investigation in the resin and coating field are:

a. Laboratory of *M. G. DuPont,* Director of the Ecole Normal Superieur, under whose guidance a number of students are doing work on natural and synthetic resins, terpene derivatives, solvents and plasticizers.
b. Control Laboratory of the National Coservatory of Arts and Crafts, under *Monsieur G. A. Boutry.* Here important work is being carried on in the use of spectrophotometer and the electro microscope.
c. The Laboratory of the Pitical Institute, which is doing work on colorimetry under *P. Fleury.*
d. X-Ray Laboratory of *J. J. Trillat* in Bellevue.
e. Study of Oils by *Monsieur Carriere* at the Laboratory of the Science Faculty, Montpellier.

Of course, there are many government and private laboratories who are also conducting considerable work. These include: The Paint Commission for the Reconstruction of City Development; Corrosion Studies Commission under the Auspices of the Merchant Marine and Navy; The General Paint Commission of the French Association for Standards—(A.F.N.O.R.), Paint Commission of the National Society of French Railroads, and Information Center for Color under the A.F.N.O.R.

Individuals who are contributing to the advancement of French Paint technology are the following:

Robert Morlock has done considerable work on surface field-forces and the spreading of liquids.

Maurice Nortz has been especially interested in Chromates as corrosion inhibiting pigments. In this respect, Nortz has developed processing techniques for producing zinc tri-hydroxy chromate. Preliminary tests have revealed that zinc hydroxychromates have very low stability in water and that they are very easy to manufacture.

Technical Developments

IN considering technical developments, two categories must be considered: (1) those referring to improvements in raw materials, production processes and final product; (2) those referring to the construction of new factories, and organization of new laboratories and experimental stations.

Work in the first category consisted of improvements in synthetic resin such as phenolics, alkyds, vinyls, ureas, melamines, etc. Improvements have been made in white pigments such as zinc whites, lithophone, titanium dioxides, etc. A development which shows promise is lead cyanamide in that it possesses excellent corrosion inhibiting properties.

Other developments worthy of mention are the improvement made in the production of various mineral pigments such as ochres, barium sulfate, and calcium carbonate and mineral black. There is no doubt that the best ochres are obtained in France. Their richness in color has not been duplicated elsewhere.

In regard to new factories, one cannot overlook the modern factory of Societé Astral—Celluco at Montataire. This is considered as the last word in paint production facilities and equipment.

As far as new experimental stations are concerned, mention must be made of the new laboratory at the Port of Le Havre. This laboratory deals with work on submarine paints and has been in operation for two years. Many discoveries found in this laboratory have already been transferred into production.

International Activities

THE French Paint, Pigment and Varnish Industry has taken increasing interest in developing paint products beyond the French border. It has proceeded in establishing numerous branch factories and control laboratories in the colonies and mandate territories. At the present time, it is also negotiating with foreign concerns for exchange of production licenses, etc.

In an effort to enhance neighborly cooperation, the French Paint Industry has sponsored two International Congresses in Paris, which were of tremendous success. The first Congress was dedicated to the techniques of production and was held on October 1–6, 1947; the second was concerned with techniques of application and was held October 19–22, 1949.

Here are some representative comments made at the first congress:

Jean Borel, President of the Executive Council: "It is indeed a great pleasure to see gathered here such a great number of foreign delegates, and we heartily welcome you. I wish to thank you for having interrupted your work in order to be present here and to join us in exchange of ideas.

I want to especially greet *Dr. J. J. Mattiello,* the official delegate of the *National Paint, Varnish and Lacquer Association* and the *Federation of Paint and Varnish Production Clubs* in the United States. In spite of all his difficulties he did not hesitate to make this long voyage in order that he participate with us in this meeting. It is a great honor for us to have him with us."

H. Rabaté, Secretary General: "It is indeed very pleasing to us that this first great International Congress of Pigment, Paint, Varnish and Related Industries be held here in Paris and we wish our foreign friends the warmest welcome.

Our industry does not ignore what is being done all over the world. America is the country with outstanding accomplishments. Her chemists and physicists have made sensational developments in all fields. Among these are the production of pigments, synthetic resins, nitrocellulose, solvents, plasticizers, paints with high chemical resistance, submarine paints; the development of test methods and standards for raw materials and finished products, etc.

During this convention we can view the paint industry as a whole with immense future possibilities, and also discuss possible solutions to the problems which arose during the recent war."

Mr. Robin, Director of the Chemical Industries Division in the State Department of Commerce and Industry: "I wish to welcome all the members of the convention, and especially those from abroad who are willing to present results of their scientific experiments and discuss their work at the various technical sessions. I am happy to see so many research men and technicians gathered here to exchange ideas and compare results. The study of the problems related to surface coating has opened new horizons for manufacturers. It has allowed them to utilize new chemicals which are better adapted for general use. New manufacturing techniques and methods seem to have a great future. Modern machinery allows safety in material handling and production which at first seemed dangerous."

Here are a few sentences uttered by the late *J. J. Mattiello* at the banquet closing the First Congress: "It is a great privilege for me to be here on this memorable occasion. The French Committee which has organized this First International Congress of the Paint and Related Industries deserve the congratulations of the whole world for their initiative in making plans for these meetings and for the success in carrying them through. I say now, in closing, and with sure knowledge that it is echoed in the hearts of all the delegates attending this magnificent Congress that the peace-loving nations of the world shall live forever. Lifting my glass of wine to the men and women of France, we say 'Vive La France.'"

During the course of the First International Technical Congress, the Legion of Honor was awarded to Dr. J. J. Mattiello, a veteran of World War I. The ceremony in awarding the Cross took place at American Chamber of Commerce in the presence of *R. Weeks* whose friendly cooperation has provided us with many contacts and representatives of the American paint industry.

The visit of *Mr. G. Stuart,* Executive Director of Painting and Decorating Contractors of America, was indeed gratifying. Mr. Stuart speaking before the Congress outlined the organization of painting and Decorating Contractors and showed the importance of the studies that are being made in the United States in respect to the application phases of paints.

Finally we were very honored by visits of *Dr. J. S. Long* during the spring of 1949, and *Robert Matlack,* President of the Federation of Production Clubs last December. The visit of *F. Weed,* President of the Rinshed-Mason Company last March was welcomed. Mr. Weed also prepared the paper entitled "Industrial Finishing," which was presented at the First International Technical Congress by *Capt. Roy W. Hall* of Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

In reciprocation of the visit of our American Colleagues, we have sent several delegates to the various American conventions and meetings. I am referring especially to the visit of some twenty paint technicians to the 1947 Convention in Atlantic City.

This delegation was headed by Robert Lefranc, President of the Federation of Paint and Varnish Manufacturers, Pierre Germot, Vice-President of the Federation, and Roger Mathieu, Treasurer, and Lucien Ravel.

In addition, this group visited many factories and laboratories which included a tour of the Bureau of Standards in Washington.

The visit of Mme. M. Caillaux to the Second Paint and Varnish Symposium held at New York University is another example of French representation at American meetings.

In mentioning international contacts, we cannot overlook the establishment of F.A.T.I.P.E.C. This was the result of the cooperative efforts of the French, Dutch, Italian, Swiss and Belgian delegates. This organization had its beginning at the Paris convention in 1947, and there were subsequent meetings in Milan, Charleroi in 1948, and in Basle in 1949 which culminated in a working organization.

Dr. Denzler, President of the Swiss Association of Chemists and Technicians of the Varnish and Paint Industry, commenting on the formation of the F.A.T.I.P.E.C., said that without the goodwill and spirit of mutual understanding of all delegates, this organization would never have been possible.

G. Dechaux, President of the French Association of Technicians, was elected President of F.A.T.I.-P.E.C. and his office is located in the Maison de la Chimie, Paris.

It is expected that a favorable development will take place in the French paint industry during the years to come, provided nothing radical happens to the economy of Western Europe. It is interesting to note that the French people consume a lesser amount of paint than any other people in Europe. On the other hand, French colonies and mandate countries are heavy users of paint since deterioration of paint films in such tropical climates as North Africa are

(Turn to page 59)

Switzerland

Film Formation

Alpine peaks in the Bernese Oberland

THE term "Physical Film Formation" refers to such coating films which are formed by (1) the evaporation of volatile solvents, (2) cooling of molten compounds, and other phase reactions, and (3) evaporation of water from emulsions. In all three cases, the mechanical strength of the films thus formed is greatly due to the secondary bonding forces between the macromolecules.

These secondary forces are partially dependent on such chemical factors as the type, number and distribution of the polar groups contained in the macromolecule. Geometric factors such as the form, the degree of packing, and the orientation of the constituent macromolecules affect film formation to a large extent.

The degree of massing is of importance in the film-forming process, since a certain degree of continuity must be attained in order that the resulting film be of practical value.

When a film is formed by the evaporation of volatile matter, the process can be described as a transformation of an organosol into a gel. Actually, the process is accompanied by an in-

By Dr. A. V. BLOM,
Zurich, Switzerland

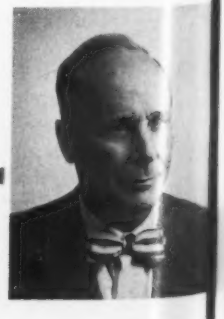


Fig. 1. Rolling ball instrument.

Fig. 2. Red lead and lead soap crystals as viewed under linear polarized light. Mag. X 560.

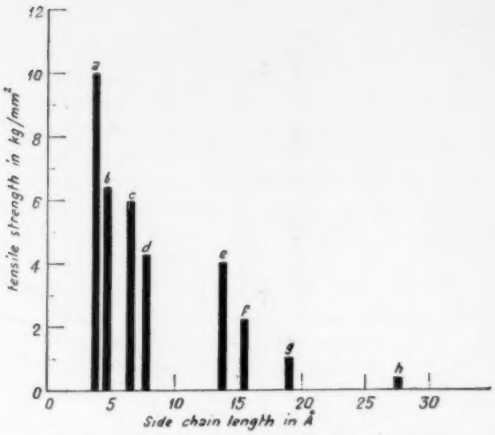


Fig. 3. Tensile strength vs. length of side chain.

crease in tackiness at the surface and later a decrease in tackiness. The rate of this film formation can therefore be determined by measuring the change in tackiness and plotting it as a function of time. For such measurements satisfactory results have been obtained by using a device which was developed by *A. G. Epprecht*. This testing method is based on the use of a rolling ball as shown in Figure 1.

The principle involved in the measurements obtained by this instrument is as follows:

The coating is applied on a glass plate which is at an even level. A steel ball, having a diameter of 15 mm, is set on one end of the plate. After 30 seconds, it is raised at the rate of one degree (angular measurement) per second, and the angle is recorded exactly when the ball begins to roll. By multiplying the radius of the ball with the sine of the angle determined, the coefficient of friction is obtained for this coating at a particular state of drying. By plotting the coefficient of friction as a function of time, a characteristic drying curve is obtained for the coating film in question.

When the physical film formation is carried out under the application of heat, the evaporation rate of volatile matter is accelerated. If the applied temperature is higher than the melting point or better the "fluid" point of the coating material, the film will penetrate the substrata to a greater degree. This will improve the adhesion of the coating film and at the same time equalize surface irregularities, and thus increase the gloss of the film.

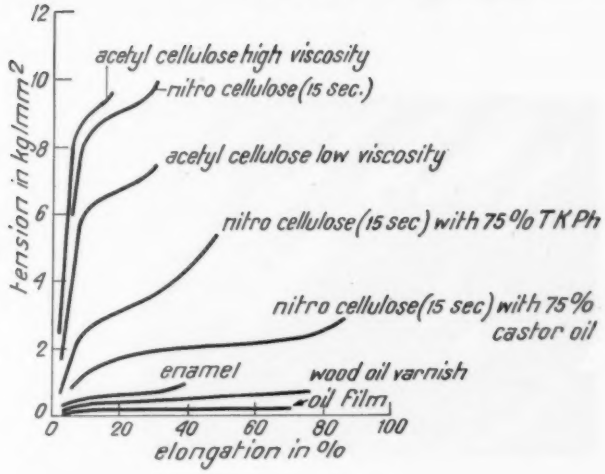


Fig. 4. Stress-strain diagram.

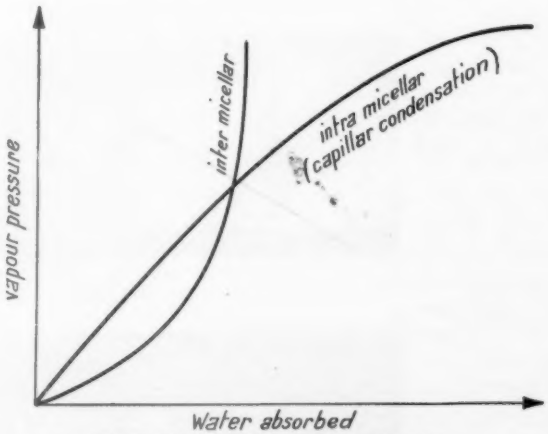


Fig. 5. Plot of vapor tension vs. absorption.

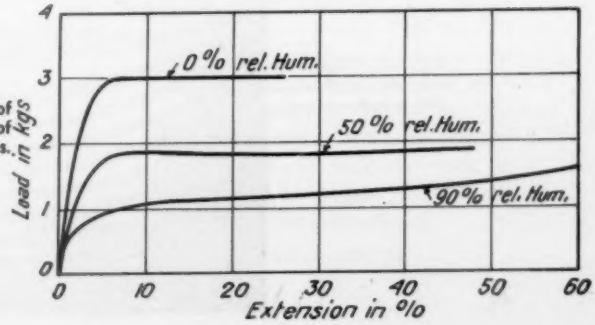
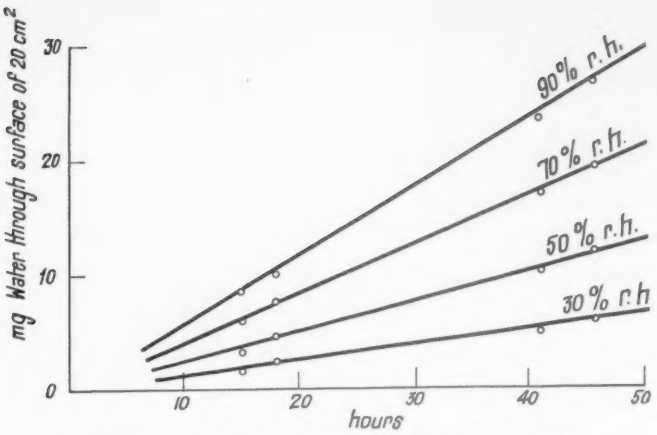


Fig. 6. Stress-strain curve of tung oil varnish in air of different relative humidities.



Plot of diffusion of water through an oil film, 80 microns thick.

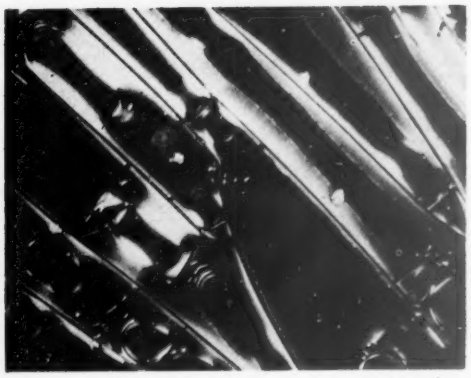


Fig. 8. Zones of double refraction under polarized light. X270.

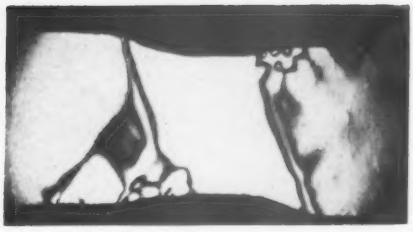


Fig. 9. Floating figurations in varnish film stretched 9.7%.

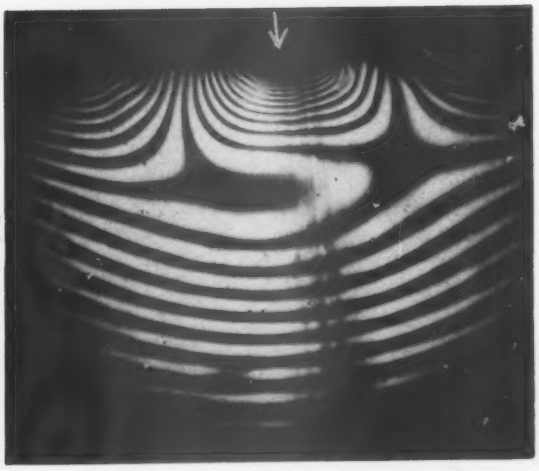


Fig. 10. Temporary stresses noted while film is under pressure.

Chemical Film Formation

IF the film formation is caused in some way by an intermolecular cross-linking, the resulting films show greater mechanical and chemical resistance. This is caused by the fact that the film-forming substance is further consolidated by the transformation of secondary bonding forces into primary valence forces. As the film-forming substance changes chemically relative to the initial compound, it will have a tendency to become insoluble and infusible. The swelling tendency of cross-linked films is usually considerably less than films obtained from physical formation.

There is essentially no difference in film properties if the film is based on pre-formed macromolecules or if the macromolecular structure is being developed during the film formation process. The factors which determine the mechanical film characteristics are the size, shape and packing of the macromolecular structure elements.

Chemical reactions in a film may still occur after some time. In such cases, film characteristics are changed during aging. A reaction of the type which may have a favorable effect in improving the chemical and physical characteristics of a film is the interreaction of base pigments with the acidic decomposition products of linseed oil. In this respect, consider the well-studied lead based paints. Figure 2 shows a red lead particle which has been exposed to acidic linseed oil. By double refraction, one can see that crystalline needles of lead soap have been formed.

Chemical film formation may proceed at room temperature as in the case of air-drying varnishes. It occurs at a temperature higher than room temperature and is limited to baking varnishes.

Film Structure

OIL-BASED paints produce a cross-linked structure based on the peroxides of tri-glycerides of unsaturated fatty acids. However, these structures are not very well known. Natural gums, on the other hand, consist of macromolecules. The film formation of natural resins are the result of the macromolecules agglom-

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This article was translated by Dr. Max Kronstein of New York University.

erating into aggregates which are held together by a secondary bonding mechanism. Only in the case of synthetic varnish raw materials do we have a more detailed insight into the film structure.

The most important factors which determine the mechanical properties of such films are: (1) the length of monomer structural elements, (2) the position of the functional groups in the macromolecules, (3) size and shape of the macromolecules, (4) the degree of cross linking and the width of the structural mesh.

It is generally known that satisfactory strength in films can be expected only after a certain molecular size has been reached. If side chains are present, they may decrease the secondary binding forces and this factor becomes more profound as the side chain increases in length. Thus the tensile strength will decrease as the length of the side chain increases. As an example, a number of cellulose esters are presented together with their tensile strength in Figure 3.

Referring to Figure 3, the side chains in the cellulose ester are a-Acetate, b-Propionate, c-Butyrate, d-Valerate, e-Pelargonate, f-Caprionate, g-Laurate, h-Stearate.

The tensile strength is dependent on the macromolecule structure as a whole. This is shown in Figure 4. Here the tensile strength was determined from films which were produced from a series of different varishes. Films of cellulose acetate (high viscosity) and those of nitrocellulose (15 second type) have high moduli of elasticity. By adding plasticizers to these, a medium or low moduli of elasticity is obtained, but the film toughness is improved considerably.

The resulting shape of the macromolecule during its formation has a definite influence on the viscosity and concentration of the solution in question. The macromoleculer shapes may be summarized in these groups as: chains, clusters, and cross-linked formations.

Chains are kept together by secondary forces, which decrease in the course of swelling and plasticization. These forces are increased by orientation of the molecules, which results in an increase in tensile strength accompanied by a decrease in extensibility.

THE AUTHOR

Dr. A. V. Blom was born in Berne, Switzerland on January 16, 1884 and studied at Berne University where he majored in Chemistry, Physics, Mathematics, and Philosophy. In 1907 he recevied the Ph.D. degree and graduated with high honors (summa cum laude). After graduation he joined the research laboratory of Aktiengesellschaft fuer Anilinfabrikation at Berlin and within two years became production supervisor in a dyestuff factory at Wolfen, Germany. During World War I, he produced explosives and gunpowder for the Swiss Army, and organized and directed the experimental laboratory for gas protection.

After the War, Dr. Blom established and operated dyestuff and pigment factories in Sweden and in England, and later was an active consulting chemist on corrosion problems.

From 1927–1947 he was Chief of the Paint, Varnish and Corrosion Research Department at the Swiss Bureau of Standards at Zurich. At the present time he is a consulting chemist in the field of plastics and paints.

Clusters are formed by the agglomeration of long chains, by polymerization in the presence of side chains and by a partial cross linking of long chains. This structure is found quite frequently in natural gums.

Cross-linked Formations are derived from polyfunctional structural elements. They present the densest film structure. Primary binding mechanisms influence considerably the mechanical strength. The capacity of being deformed depends largely on the width of the structural mesh.

Morphological Aspects

SINCE it is known that the shape of the macromolecule actually influences the characteristics of films, a new method has been investigated, other than the use of the microscope, in order that a study of this phenomena can be made.

The modern methods of investigation involving the fine structure of matter include X-rays, Electron Diffraction, Infrared Spectroscopy. All these aid in presenting a study of the structure of macromolecular matter and the type of their linkages.

Since it has become possible to see, by the use of the electron microscope, individual macromolecules and their degree of packing (and even take photographs of them), earlier consideration about the relationship between the structure and physical characteristics of coating films have been borne out and have been consolidated into a well based theory.

Photos of the influenza virus and of necrosis proteins show us how round agglomerations of macromolecules orient themselves into hexagonal globular units. We except that similar conditions exist in the globular molecules of resinous substances.

The conceptions regarding the formation of long polyester chains and their elongation by diisocyantes are now being explained on a new basis resulting from investigations of actinconversions.

We are today on the threshold of new perceptions. The electron microscope will enable us to make many theoretical conceptions an actual reality because we will be able to actually see what is going on. We shall be in a better position to draw conclusions from a series of observations. Thus, new fields will be open to research and investigation which, heretofore, were based on speculative thinking.

For a complete understanding of the relations between the structure and physical characteristics of films, it is essential to have an exact conception of the macromolecular structure itself.

Two-Phase Theory

A SOLIDIFIED substance such as we find in a coating film may be regarded as two phases: one dependent on temperature, and the other not dependent on temperature. The first has characteristics which may be described as "plastic deformable," whereas the other corresponds to an elastic deformable substance. Based on this conception, we can say that a macromolecular film consists of an elastic framework imbedded in a plastic phase. Thus, polymers having a low molecular weight may appear as a viscous solution, but when a certain medium molecular size is reached, this same material will exhibit plastic-like characteristics.

(Turn to page 60)

the Netherlands

By DR. JOHAN HOEKSTRA,
Philips Research Laboratory
Eindhoven, Holland

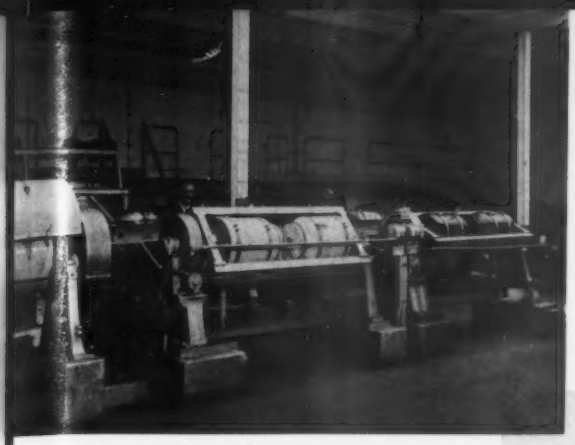
THE Paint Industry all over the world and especially in Holland is much older than the chemical industry, but today she obtains by far the greater part of her raw materials from her younger and bigger sister, Paint Technology.

The reason why Holland has made paint since the Middle Ages was that it always imported wood and linseed from the Baltic. The wood was used to build houses. The linseed was used to make linseed cakes for the cattle and linseed oil with which to make paint to preserve homes. This industry was mostly done in windmills (oilmills).

In Holland, paint making during the old days was done by the painters themselves. They had a very refined technique for mixing pigments and oils. All the Dutch artist painters of the 17th and 18th centuries like Rembrandt van Rijn, whose father was a miller, van Dijk, Adriaan Brouwer, Frans Hals, were skillful in making their own colors. Their work is extremely well conserved, showing little cracking and no fading. However, age darkening, which can, and nowadays mostly is, removed by restoration, is partly due to thick layers of alcohol-soluble darkening varnish on the surface of the paintings, and, partly to the use of lead pigments in combination with H_2S from the Dutch canals ("grachten").

Courtesy of The Netherlands National Tourist Office

Tholen



Row of pebble mills in modern Dutch plant.

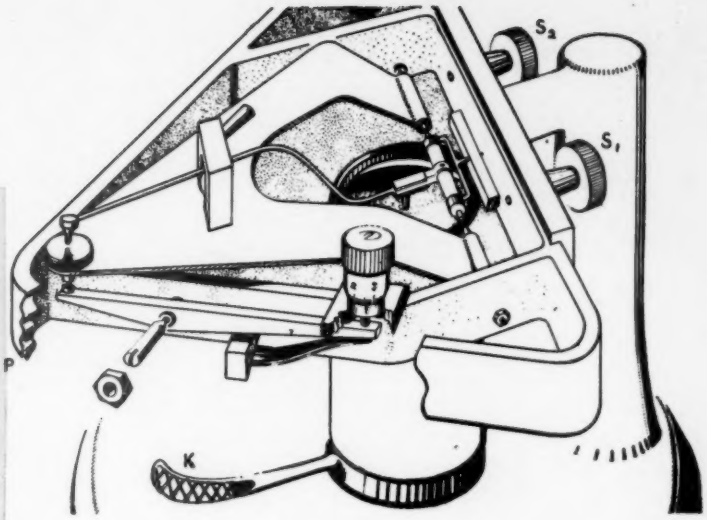


Fig. 1. Dr. Dantauma's thickness gauge gives low contact pressure at paint surface layer.

Philips Laboratories at Eindhoven, Holland.

Pigments were manufactured in Holland, too, though many raw materials were imported. In the 16th century mercury and mercury pigments, for instance, were sold all over the world almost solely through some big Amsterdam merchant houses. The manufacture of red cinnabar was done in Amsterdam. The production methods were kept so secret that they are lost now. The oil trade was also concentrated in Amsterdam thanks to the Dutch windmills. These wooden machines, constructed without the use of metal nails, enabled the windmill owners to establish mechanical production long before steam and electricity. These Dutch enterprisers, however, were at heart merchants rather than industrialists. They stopped producing goods the moment they could buy it cheaper in some part of the globe, and it was only during the end of the 19th century that at a few places in Holland, especially at Zaandam, north of Amsterdam some real chemical and allied works arose from the old windmills. They were oil and linoleum works, wood and paper mills, and paint works. The first mill making linseed oil was erected about 1570. The Dutch, during this time, had not only produced a few billions worth of noteworthy paintings, but had also invented some very useful materials in the field of housepaints, like Dutch lead, (made originally by the use of horsedung) and, about 1800, standoil. One can say that the paint industry definitely grew out of the windmills.

Raw Materials

IT is a good thing the glory of our paint industry is not a thing of the past. Besides being very old, ours is a highly developed industry, producing and exporting all sorts of old and modern house, industrial paints and varnishes. Our oil industry, including linseed and dehydrated castor oil and several treated oils and siccatives, was already mentioned. Furthermore, there are quite a number of firms making all types of new resins (like all sorts of alkyds, pure and modified resin types, 100% phenolics, styrenated oils, chlorinated rubber, rubber hydrochloride, modified rosins and resins, etc.) and a number of high polymers (cellulose acetate, cellulose nitrate, polycaprolactam, polyvinyl chloride).

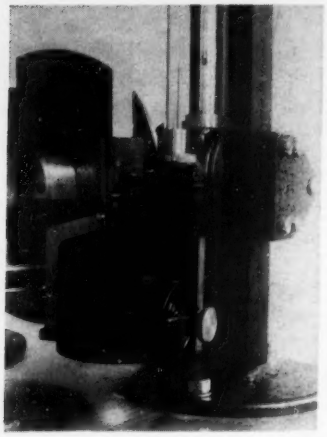


Fig. 2. Apparatus for elongating paint films at fixed speeds.

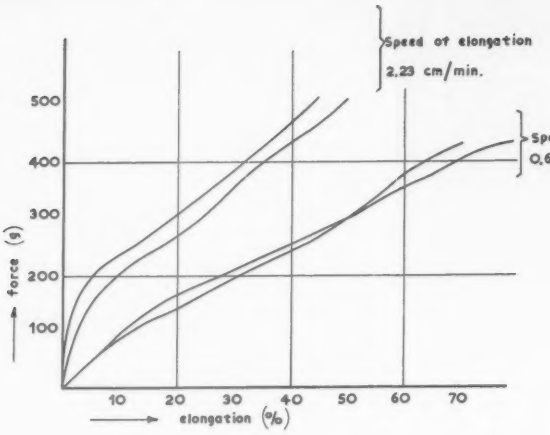


Fig. 3. Stress-strain curves of paint films.

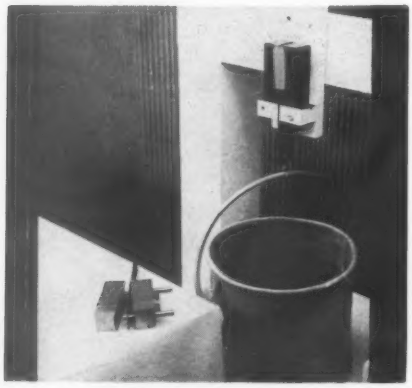


Fig. 4. Testing adhesion by using two blocks screwed on both sides of a thin steel strip. The surface is ground flush and lacquered. The bolts are removed and the strip is drawn parallel to painted surface between blocks.

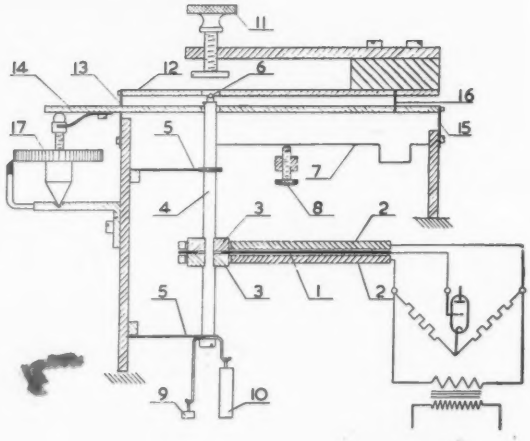


Fig. 5. Device for testing micro hardness.

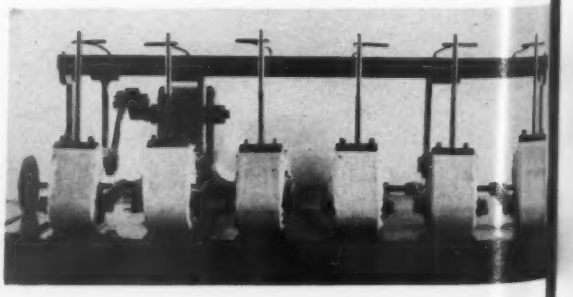


Fig. 6. Testing "soft" wear..

THE AUTHOR

Dr. Johan Hoekstra was graduated from Amsterdam University in 1932. He was a research fellow of the Dutch Rubber Institute where he worked on the measurement of plasticity. He was connected with the Philips Research Laboratory at Eindhoven and the Pope Co. at Venlo as a research chemist developing improved insulation materials. Presently, he is chief chemist at the Philips Company in charge of developing paint and varnish materials for use on electrical equipment. Dr. Hoekstra is the present president of the Paint, Bitumens & Plastics Section of the Dutch Association for the Knowledge of Materials.

There are also a number of old-established firms, making pigments like the well-known Dutch white lead, zinc, lead and chromate pigments, ultramarine and prussian blues, some organic and several mineral colors. The basic raw materials of most of these Dutch industries are imported, and a good part of the goods produced is exported.

Holland until now, has no autonomous big chemical industry, offering an ever-growing supply of new basic materials, as the United States, England, Germany, France, and Italy. The reason for the relative lack of chemical background lies in the scarcity of raw materials in the Low Countries. We have almost no basic minerals at all, and have to be content with clay, sand, salt, potato

(Turn to page 61)

ANNOUNCING...

The Western plant and facilities of W. C. HARDESTY CO., INC. *at Los Angeles, have been acquired by Vegetable Oil Products Company, Inc., and will operate as*

VOPCOLENE DIVISION OF
VEGETABLE OIL PRODUCTS COMPANY, INC.

The fatty acids and specialty products manufactured by this plant will be marketed under the new distinctive trade name VOPCOLENE. We invite you to write for a brochure describing properties of these VOPCOLENE products.

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Denmark

By KNUD CHRISTENSEN,
Sadolin & Holmblad, Ltd.

DENMARK is a pronounced agricultural country and has, inside her borders, no access to the raw materials used in the chemical industry. In spite hereof, the paint and varnish industry has in the last few years undergone a development, causing a remarkable industrial expansion, so that today the Danish paint and varnish industry is considered one of the most modern in Northern Europe. This is shown by the big export market, which Denmark has been able to achieve, while the Danish industry simultaneously has extended and enlarged its production to include also synthetic resins, pigments, etc.

The Danish paint and varnish industry has established an association, comprising about 40 concerns in the trade. Most of the factories are small, but there are 5 or 6 larger plants, which produce about 75 percent of the total Danish turnover; and these large factories are also responsible for most of the export.

There are essential differences between the American and Danish paint industries. Most houses in Denmark are made of bricks. Thus, the manufacture of white house paint is of only minor interest. On the other hand, large quantities of oil pastes are sold which the painters themselves mix with oil or varnish; the sale of ready-made colors is therefore relatively smaller in Denmark than

Towers of Copenhagen

Courtesy of the Danish Information Service

in the United States. However, there is an unmistakable tendency among the painters to change to the use of ready-prepared paints and the marketing of many new types of paint intensifies this trend. Emulsion paints have been of little importance since World War I, but it is possible that emulsions made of synthetic rubber bases may obtain the success to which they are entitled.

Organization

THE Danish paint and varnish industry has for many years understood the importance of a rational organization in production, as well as the advantage of extensive research and testing programs. Denmark has, therefore, been the leading country in Scandinavia in the employment of scientific educated personnel, and today more than 100 chemical engineers are engaged in the paint industry.

In a presentation of this industry, no injustice will be made in emphasizing the importance of *Sadolin & Holmblad Ltd.*, the oldest and largest concern in Scandinavia, established as early as 1777. Developing slowly through the years, S. & H. had an explosive expansion during the first World-War, when the isolation of Denmark caused an enlarged production of all kinds of paint as well as printing inks, which again was a basis for the establishment of a special plant producing colored pigments. Production of these pigments grew so rapidly that it became necessary to separate them from the mother concerns and establish an independent factory, *"Chemical Works Koege Ltd."*, which today is the only producer in Scandinavia of colored paint pigments. "Chemical Works Koege" has developed an export which far exceeds the requirement of the home market, and has also begun production of various other chemicals such as lactic acid, synthetic tannins, weed killers, etc.

S. & H.'s own expansion continued rapidly, not on account of the increased export of printing inks, but later because of cellulose enamels, used in the automotive industry. After World War II, it was possible for the old concern to renew its connections with customers abroad. In the early thirties, the company started production of alkyd resins which in recent years has been extended to include all the more important synthetic resins. The production of copals has given the impulse to the construction of a pilot-plant factory of phthalic anhydride, and as a result hereof the initiative was taken to establish a new factory erected specially for the manufacture of this raw material.

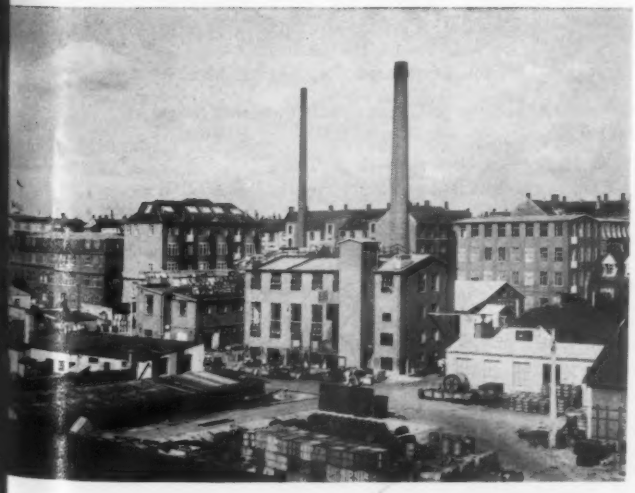
Model of the S. Dyrup & Co.

This new plant, "Kemoscandia" A/S exemplifies interscandinavian collaboration; the company having been started jointly by *Norsk Sprængstofindustri* A/S, Norway, *A/B Uppsala Eke*, Sweden, and *Sadolin & Holmblad Ltd.*, Denmark. It has a capacity to produce 5–600 tons of phthalic anhydride annually, but it is planned to double this quantity and further to take up the manufacture of plasticizers etc. A considerable part of the plant's machinery was obtained by means of the ERA, while chemical and production methods were developed in Scandinavia.

Other Plants

DENMARK has several other large paint and varnish factories. *A/S S. Dyrup* & Co. merits a mention. This concern has under the enterprising leadership of its far-sighted founder, chem. eng. *S. Dyrup*, had an extensive growth during the thirties, and he has through his many years of training in the United States, made a special contribution to the production of paints for protection of iron and steel. It is therefore natural that S. Dyrup & Co. has been entrusted with the painting of Denmark's many bridges, which connect the Danish islands and mainland. The Dyrup concern grew so

(*Turn to page 63*)



View of a part of Sadolin & Holmblad

FEDERATION CONVENTION PROGRAM
Congress Hotel, Chicago, Ill.

Wednesday, November 8

Afternoon

2.00 P.M. Registration
Annual Council Meeting
6.00 P.M. Council Dinner
8.00 P.M. Registration Closes

Thursday, November 9

Morning

9.30 A.M. Opening of Paint Industries' Show
10.00 A.M. Meeting Opens: Greetings by President A. T. Montanye and welcoming by P. M. De Leeuw, President of Chicago Club, and T. F. Byron, Chairman of the Host Committee.
The Effect of Zinc Oxide on Architectural White Alkyd Enamels by Baltimore Club.
Report of Paint Industries' Show Committee by C. J. Overmyer, Chairman.
Annual Report by President A. T. Montanye.
Address by J. F. Battley, President of National Paint, Varnish & Lacquer Assoc.
Report of Materials Committee by W. P. Colio.
Luncheon.

Afternoon

2.00 P.M. Water in Oil Emulsion Varnishes and Paints by Dr. Wouter Bosch.
Report of Standards and Methods of Tests Committee by M. A. Glaser, Chairman.
The Joseph J. Mattiello Lecture by T. F. Bradley.
A Theoretical and Statistical Study of Sward Rocker Hardness Determinations of Paint Films (Oil and Colour Chemists' Ass'n.)
Evaluation of Bodying Agents in Gloss Enamels by Golden Gate Club.
4.10 P.M. Annual Business Meeting

Friday, November 10

Morning

10.00 A.M. Meeting opens.
Measurement of Hiding Power Using the Hunter Reflectometer by Toronto Club.
Report of Joint Federation-Association Educational Committee.
Report of Manufacturing Committee by N. T. Phelps, Chairman.
Address by Dr. A. P. Haake, Consultant to General Motors.
A Torque Meter for Measuring Power to Plant Mixers by Dr. D. E. Mack and V. W. Uhl of Lehigh University.
Report on Foreign Activities.
"At What Price is an Expensive Paint a Good Bargain?" by Federation of Technical Association of Paint Industries of Continental Europe.
Luncheon.

Afternoon

2.00 P.M. A Method for the Evaluation of Alkyd Resins for Stoving Finishes by Birmingham (England) Club.
Standard Methods of Testing and Evaluating Deep Tone Flat Wall Paints, by New York Club.
Report on the Federation Research Program by P. O. Blackmore, J. S. Long, and W. O. Lundberg.
Project Report by various clubs.

Saturday, November 11

Morning

9.30 A.M. Meeting opens.
Plant Production Problems, Session One — Raw Materials Handling — Round Table Discussion.
Report on Activities of Scientific Section by J. C. Moore, Director.
Plant Production Problems, Session Two—Processing—Round Table Discussion.
Dispersions by New York Club.
Fineness of Grind by Northeastern University.
Dispersion Studies by Scientific Section of National Paint, Varnish & Lacquer Association.
Plant Production Problems, Session Three — Packaging and Shipping — Round Table Discussion.
Resolutions and Announcements.

Registration opens 8.00 a.m. each day and closes at 5.00 p.m.

Paint Industries' Show opens at 9.30 a.m. and closes at 6.00 p.m.; Saturday, November 11, at 2.30 p.m.

SOCIAL EVENTS

Thursday, November 9

6.00 p.m. Twenty-Five Year Club Dinner
8.30 p.m. Annual Bridge Tournament

Friday, November 10

7.00 p.m. Annual Banquet—Awards and Entertainment
10.00 p.m. Dance

NPVL ASS'N. CONVENTION PROGRAM
Fairmont Hotel, San Francisco, Calif.

Wednesday, November 15

Afternoon

Business Session and Officers' Reports.
"State of A Nation" address by Leo M. Cherne, Executive Secretary of Research Institute of America.

Thursday, November 16

Morning

Reports on Clean Up-Paint Up, Paint Power, Color, etc.

Afternoon

Presentation of General Advertising Campaign for 1951.

Friday, November 17

Morning

National Security Day. Key government figures will be invited to tell of their plans and how they will affect the paint industry. Commerce, Treasury, National Security Resources Board, Manpower, Priorities and Allocations, etc. will be discussed.

Afternoon

Raw Material Symposium.
Opening of Federation Day.
Presentation of technical papers.

Saturday, November 18

Morning

Joint meeting of the Association and Federation. Subjects of interest to management, sales and production personnel will be considered.

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Spaces 1 & 2
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Delaware Trust Bldg.
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Geo. B. Bossert, Advertising Dept.

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Seattle 8, Wash.
C. M. Ambrose, Jr., President

Spaces 4 & 5
Patterson Foundry & Machine Co.
East Liverpool 1, Ohio
H. M. Brown, Sales Mgr.

Space 6
Binney & Smith Co.
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New York 17, N. Y.
J. T. Kealy

Space 7
J. M. Lehmann Co.
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Lyndhurst, N. J.
C. B. Hoffman, Sales Mgr.

Space 8
Charles Ross & Son Co.
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Brooklyn 5, N. Y.
Chas. L. Ross, Pres.

Space 9
Hercules Filter Corp.
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Patterson, N. J.
Henry T. Jones, Jr., Vice Pres.

Space 10
Theodore Cornelius
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New York 7, N. Y.

Spaces 11 & 12
Advance Solvents & Chemical Corp.
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A. B. Mullaly, Pres.

Space 13
Plaskon Division,
Libbey-Owens-Ford Glass Co.
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Toledo 6, Ohio
George A. Taylor, Adv. Mgr.

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Oakley K. Garlich, Secretary

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Chemical Department
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Space 25
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Kirby Allen, Adv. Dept.

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M. K. Pinkerman, Adv. Mgr.

Space 30
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J. L. Boyer, Director, Technical Sales

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Union Carbide & Carbon Corp.
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R. W. Matthews, Sales Prom. Mgr.

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W. W. Newell, Asst. Adv. Mgr.

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E. S. Anderson, Asst. Sales Mgr.

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W. G. Andrews, Dir. Sales

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Washington Square
Philadelphia 5, Pa.
Gerould Allyn

Space 61
R.B.H. Dispersions Division
Interchemical Corporation
Bound Brook, N. J.
O. D. Bluthardt, Div. Vice Pres.

Space 62
Anderson-Prichard Oil Corp.
1000 Apco Tower
Oklahoma City 2, Okla.
C. H. Dresser, Vice Pres.

Space 63
South Florida Test Service
4201 N. W. 7th St.
Miami 34, Fla.
E. M. De Noon

Space 64
Atlas Powder Co.
Wilmington 99, Del.
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Germany

DR. GERHARD ZEIDLER
Paint and Varnish Research Laboratories,
Berlin, Germany

Courtesy of the German Tourist Office

Rottweil on the Neckarm, near the Black Gate

IT is quite obvious that in reviewing the developments in the German paint and varnish industries during the last few years, it is necessary to commence with the last years of World War II, since the years between 1945 and 1948 showed practically no progress. Raw materials were scarce, and it was found necessary to use all the materials remaining from old, more or less depleted stocks. Only small quantities of new paint and varnish materials were produced and research remained at a rather modest level.

War Research

A CERTAIN amount of research was carried on nevertheless, although the results produced during those days, as far as new combinations were concerned, could really be called adventurous rather than scientific. The paint and varnish industries were forced to employ many unusual raw materials for their purpose in order to replace those which were unattainable at that time. One of the interesting varnish raw materials developed during those years was *Carboresin,* a by-product of the Buna synthesis. This resin is a slow drying mineral oil product used in the manufacture of paints of relatively fair weather resistance. However, it was almost impossible to cover films of this material with varnishes of other compositions such as nitrocellulose lacquers (oil lacquers were practically non-existent), since different polarities of the films resulted in poor adhesion.

A better raw material was *Pervinan,* a synthetic oil containing ole-

THE AUTHOR

Dr. Gerhard Zeidler was born in Rostock in 1901 and studied chemistry at the University of Berlin and Dresden obtaining the degrees of Diplom Engineer and the Dr. of Engineering. The latter degree was awarded for his work on a study for removing paint films from their substrates which led to the development of the Rumpometer for accomplishing this purpose.

Dr. Zeidler worked for a few years in a large varnish factory where he assisted Dr. Heinrich Zellner. Later, he established his own research laboratories in Berlin in which he did considerable work on paint and varnish technology. The results of this work have been published in numerous German, American and English journals. Dr. Zeidler was a pupil and later an associate of Dr. Hans Wolff. At the present time he holds an importatn position in the German Standards Committee which was recently established.

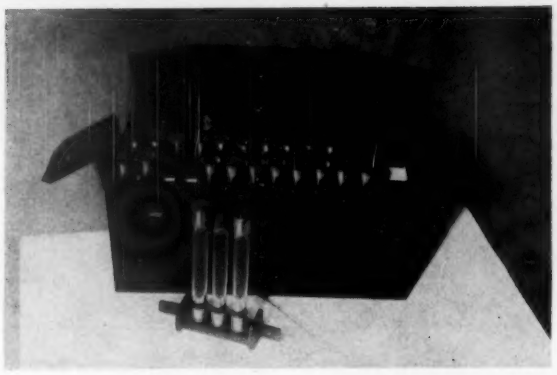


Fig. 1. Viscosity tubes with 30 steps.

fins which, if suitably siccativized, formed fairly good air-drying paints and also better baking enamels. The only serious disadvantage of Pervinan was that because of a tendency toward yellowing, it was difficult to produce satisfactory white enamels.

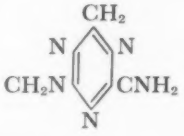
Nitrocellulose was another available raw material left over in explosive factories. If dissolved in available solvents together with available resins and plasticizers, a number of fairly satisfactory second-grade lacquers were produced. The paint and varnish industries in Germany also got used to the application of moist nitrocellulose. Indeed, after having been forced to use this for a while and developing correspondingly modified processes, it was found that a certain percentage of water actually proved advantageous since it exerted a certain influence on the solvent capacities of the systems. A number of interesting articles have been published on this subject some time ago.

Synthetic Resins

THE valuable synthetic resins developed through the isocyanate addition processes during the war, and which found universal application in form of *urethan resins* and *urethan oils* were practically unavailable after 1945, although further developments have been effected during the last few years. The basic reactions leading to the production of these substances are as follows:

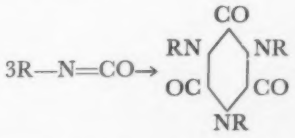
It is generally known that the atom grouping *CNHO* is characterized by a high degree of reactivity irrespective of the type of the three modifications in question:

a) HO—C=N, the well-known cyanic acid is easily polymerized to cyanous acid, the raw material of the triamide known as melamine which represents the characteristic constituent of the valuable melamine resins:



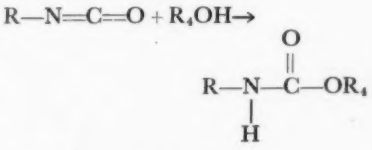
These resins (European trade name: Maprenal) are characterized by a high degree of light resistance and yield films of exceptional gloss at comparatively low baking temperatures.

b) HN=C—O, i-cyanic acid; the high degree of reactivity of this grouping of atoms has become of great importance in the varnish industries. The acid itself, as well as its alkyl ester, are easily polymerized to their trimers:



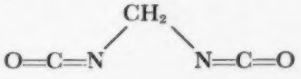
I-cyanic acid esters are formed in which R is not combined with C but with N.

The high degree of reactivity of the monomeric i-cyanates is due to the fact that they are able to form straight additions to groups containing OH or NH_2 of other compounds, a surprising feature being the fact that in these reactions the H-atom of the OH and NH_2 groups is replaced to the N-atom of the i-cyanate. The basic reaction for the new group of poly-urea or poly-urethane compounds is as follows:



This formula shows that comparatively long molecular chains are formed even over the hetero-atoms, although this reaction is not sufficient to form molecular combinations (macro-molecules), which are of practical interest to the paint and varnish industries.

It was the idea of *O. Bayer* to replace the radical R present in the isocyanate R—N=C=O by a second cyanate which led to the formation of new compounds of the following type:



These new compounds reacted as expected, and since the higher alcohols such as, for instance, hexantriol or even the macromolecular types such as polyvinyl alcohol can be obtained at comparatively low prices, it is obvious that this synthesis is versatile technically as well as economical. It permits the production of long-chained or, if desired, even of cross-linked molecules.

These new varnish raw materials thus represent products of well defined reactions taking place within a

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St. Peter's, Rome

Courtesy of the Italian Tourist Office

Italy

By DR. DANTE PAGANI,
Milan Polytechnic Institute

THE paint and varnish industry is one of the oldest manufacturing activities in Italy, but it was not until the end of the last century that it gained a prominent position in Italian industry.

Production of paints and allied coatings have always been at about the same level. Immediately after 1914, production of paints reached 120,000 tons and steadily increased up to 1929. From 1929 to 1932 Italy, like other nations, experienced a depression and as a result, her production of paints fell accordingly due to the lack of buying power among her people. With a brighter economic picture after 1933, production increased steadily and in 1940, the Italian paint industry reached a high of 350,000 tons. Statistics are not available during 1940–1945, but the 1946–1947 period topped the 1940 record by 50,000.

Up to 1923 most of coatings were of the oleoresinous or varnish types. Later, synthetic resins were given more attention and it was not long before many coatings based on synthetics were marketed.

Raw Materials

IN order to fully understand the Italian paint industry, one must recognize two important factors:

a) Availability of raw materials.
b) Preparation of raw materials from basic chemicals.

Raw materials consumed by the Italian paint industry are drying oils, natural resins, synthetic resins, and mixed resins, etc. The following list contains types of materials used and their origin.

Drying Oils—Oils are used mostly for producing varnishes and oil-modified resins. These include cotton seed, grape seed, soja, and oiticica. Soja and oiticica are imported, whereas grape seed is a product of Italy.

Cotton seeds are imported and the oil is extracted by Italian processors. In 1949, 195,044 tons of cotton seed were imported and from January to April 30th of this year, 202,694 tons were imported.

Natural Resins—Manila resins, acaroid resins, benzoin, sandracca, dammar, copal, rosin, etc., are imported from European, African and Asiatic markets. About 5,000 tons of natural resins were imported last year.

Synthetic Resins—Vinyls, methacrylates, acrylics and styrene are imported. Synthetics are also produced from the following available raw materials such as phenol, formaldehyde, cresol, glycerine, and phthalic anhydride.

Basic Chemicals

Phenol—Since 1935, phenol was obtained both from coal tar and from gas residues. These sources netted some 1,500 tons of phenol per year, but this amount was not adequate to meet domestic demands. Thus in 1934, phenol was first produced synthetically and this resulted in some 900 tons per year. However, Italy continues to import phenol to satisfy her demands.

Cresol—Cresol is imported exclusively; 345 tons were imported last year.

Naphthalene — This important chemical is obtained from coal and gas residues in part but a great portion is imported. In 1949, one and one-quarter tons of refined cresol and 4,900 tons of an unrefined type were imported.

Formaldehyde—Formaldehyde is completely produced in Italy. Approximately 80 per cent of the phenol, formaldehyde and napthalene produced in Italy is consumed by the paint and varnish industry.

Glycerine—Glycerine is produced in Italy and in 1946, some 7,000 tons were produced as compared to only 1,786 in 1947.

THE AUTHOR

Dr. Dante Pagani is professor of Applied Chemistry at Milan Polytechnic Institute and is also manager of the Research Laboratory at E. Marelli & Co. He is president of the Italian Association of Varnish Industry and a member of Board of Federation d' Association des Tecniciens des Industries des Peintures, Vernis, Emaux, et Encres d' imprimerie de l' Europe Continentale and secretary of the Lombardy Branch of the Italian Chemical Association.

Dr. Pagani has done considerable work on the drying process of linseed oil in the presence of various catalyst. As manager of the Marelli Research Laboratory he has been engaged in work on insulating varnishes and compounds. One of these, "The Evolution of Insulating Varnishes Used in Electrical Machinery" was delivered at the 1949 Paint and Varnish Production Club Convention in Atlantic City.

Dr. Pagani took part in Basle meeting which was held in May 1949, where was founded the F.A.T.I.P.E.C.

Others

PRODUCTION of modified resin began in 1938. At that time, production capacity of resins were much less than Italian needs. Today, resin production is sufficient so that imports are unnecessary. The following represents the more important resins which are used by the Italian paint industry:

Cellulose Derivatives—Cotton linters are imported from which nitrocellulose is produced. This cellulose product is available with a 25–30 percent ethyl or butyl alcohol, and a plasticized type containing 18–20 per cent butyl phthalate. Cellulose acetate resin is also produced from cotton linters.

Bitumens and Asphalt — Large amounts of bitumens and asphalt products are available in Italy. However, the quality of these materials is very low and imports of a better quality material from the United States are necessary.

Pigments—Pigments can be divided into two types: inorganic and organic. Italy produces enough inorganic pigments, not only to meet her needs, but also to export some. Carbon black is available from coal. Organic pigments produced include nigrossine, para reds, and nitroaniline reds.

Solvents—Benzene, mineral spirits and naptha solvents are produced for the varnish industry, which consumes about 1,000 tons. Part of the solvents consumed is produced in Italy and part is imported. All mineral spirits are imported. Napthas are plentiful through Italian production.

Lacquer solvents, such as methyl and ethyl acetate, methyl, propyl and isobutyl alcohol and acetone may be produced in Italy but it was found that importing these solvents was cheaper, since the chemical processes involved in producing them are more expensive. Isobutyl ketone and methyl isobutyl ketone must be imported.

Plasticizers—Methyl, ethyl and butyl phthalate are produced. Phosphate and glycol types are imported.

Driers—Most of the driers used by the Italian paint industry are produced there, but napthenic and cobalt types must be imported.

Present indications are that production of coating materials for this year will far exceed the 1940–1949 period total which amounted to 600,000 tons. The production of paint is under the jurisdiction of A.N.I.C. (Associazione Nationale Industrie Chimiche) which controls 187 establishments. To this figure, we have to add several small firms. The above establishments are mostly in Northern Italy and are broken down in the following table:

Lombardia	102
Liguria	29
Piemonte	18
Toscana	14
Lazio	9
Veneto	5
Campania	6
Sicilia	1
Emilia	3
Total	187

It is evident that more than half of the paint industry is situated in Lombardia, where Milan, the main industrial center, is located. About 6,000 workers are employed in the paint and varnish industry.

As in other countries, the increase in Italian production is attributed to the discovery of new machinery and new methods of production. Our laboratories are engaged in research work endeavoring to find better materials and methods. The future is bright. We are aiming to produce all the products which are in demand

(*Turn to page 65*)

Canada

By GEORGE FEARNLEY
International Paints (Canada) Ltd.

Gaspe at Percé

Courtesy of Canadian National Railways

TECHNOLOGICAL advances in the Canadian Paint, Varnish and Lacquer Industry are not as great in vastness or variety as those advances made in the United States or even in England. On a capita basis or an invested dollar basis, though, Canadian advances should compare favorably with other countries. This lack of tremendous technological advance is not due to lack of initiative on the part of the Canadian paint industry, but, rather to the fact, that many of the firms operating in Canada are subsidiaries of, or, have working agreements with, similar and larger organizations in either or both the United States and England. Be this as it may, paint and allied technologists in Canada are doing a great deal of work to supplement that done by parent companies in the adaptation of products to the Canadian climate and carrying developments to finality to suit local conditions.

Education and Research

ANOTHER factor which, perhaps, has deterred a great deal of work in Canada, has been the lack of scholastic training in branches of our industry. In both the United States and England courses are available in Universities and Technical Colleges in paint technology. None such are available in Canada. A step in the right direction has been taken to eliminate this weakness. Both in Montreal and Toronto, Paint Tech-

nology courses have been organized during the past couple of years, to train younger men in the ways and means of our industry. Further, a broad program of study has been undertaken at McGill University in Montreal on the chemistry of drying oils, high polymers and kindred subjects.

This undertaking started with the donation of a *Nuodex* Fellowship, tenable at McGill University, in recognition of the many papers prepared by the *Montreal Paint & Varnish Production Club* on Driers. From this beginning other associations and organizations became interested in the work and a much broader program than could be undertaken by means of the Nuodex Fellowship alone was launched. Some of the work now being done forms a part of the large program of fundamental research inaugurated by the *Federation of Paint & Varnish Production Clubs.*

A special, air-conditioned laboratory was set up for infra-red and ultra-violet spectroscopic studies of fatty acids and their derivatives, together with polymers and dried oil films. So far a great deal of work has been done on ultra-violet studies of dried films using various driers. Some work has also been done on infra-red absorption of the films but not to as great an extent as with the ultra-violet. Curves have been obtained for many oils, pure fatty acids and some polymeric compounds. This work will be carried on to a much greater extent in succeeding months. It is an ambitious program of work which will expand from year to year and may, in time, lead to a course in paint technology.

Other Programs

THE *National Research Council* in Ottawa maintains a paint research laboratory in the Division of Chemistry and a certain amount of work is being done in the building and construction division on protective coatings. The paint research laboratory is charged with drawing up specifications which are then reviewed and revised by a joint committee consisting of members of the paint industry and the members of the Research Council. Some of these specifications deal with fire retardant paints which were developed during the war for use by the Mercantile Marine and Navy. These have been modified from time to time as methods of testing were improved and greater knowledge of fire retardant paints was obtained. Work by the Research Council shows that paint properly applied retards the burning of wooden structures.

A vast program of corrosion research has also been undertaken by an associate committee of the Research Council, which includes, along with the N.R.C. scientists, members of industrial technical staffs, some of whom are from the paint industry. This committee is studying corrosion in all its phases and endeavoring to find means to reduce or overcome the annual loss due to corrosion said to be in the neighborhood of $200,000,000 per year in Canada.

The construction group at the Research Council have recently put out a report stressing the increased peeling of paints from wooden structures. They point out that as paints are improved in hardness and gloss their permeability decreases giving a greater tendency towards peeling, showing that as improvements in paint formulation are made failures of a somewhat different type can be expected. They are working on a new building code that will allow for these improvements with the harder type of finish.

Similarly, the *Ontario Research Foundation* has done a great deal of applied research relative to the paint industry. Some of this work has been done on fire-retardant paints and fungicides. A large program of work was undertaken correlating accelerated weatherometer tests to regular outdoor exposure tests. *The Canadian Pulp & Paper Institute,* in conjunction with some of the universities, has conducted work on the preparation, purification and uses of tall oil from the Canadian pulp and paper industry. Some of this work has had to do with the use of tall oil in protective coatings.

At the prairie division of the National Research Council much work had been done on the improvement of flax. Linseed oils from various types of flax have been examined and methods of producing better drying oils by solvent segregation of these different oils, using furfural as the solvent are being investigated. Another development at the prairie division is the production of glycerol by means of fermentation. It has been found that under controlled conditions, particularly regarding pH values, that certain yeasts and bacteria will produce glycerol from sugar with very good yields and without the addition of aldehyde fixatives. This may develop into another good method for the production of glycerine and thus remove its dependance on the fatty oil industry.

Manufacturing Trends

THE majority of the larger companies manufacture their own alkyds, some in movable kettles of two or three hundred gallons capacity, while others have elaborate set-kettle installations. Many are the types and variations, but most are made by the alcoholysis process and contain greater or lesser amounts of pentaerythritol. At least one resin manufacturer in Canada is now in production of styrenated alkyds and oils, on a dehydrated castor oil base. In the not too distant future, one of the larger producers of drying oils will place on the market a styrenated linseed oil, for which superiority over dehydrated castor oil co-polymers is claimed.

(*Turn to page 65*)

THE AUTHOR

George Fearnley was born and educated in England and came to Canada in 1924. He did assaying and analytical work before joining International Paints (Canada) Ltd. as a chemist in 1927.

Mr. Fearnley has been active in the Montreal Paint & Varnish Production Club and the Protective Coatings Division of the Chemical Institute of Canda serving as president of the former in 1934 and chairman of the latter in 1948. He is a member of the Technical Advisory Committee of the Federation and a delegate from the Federation to the Inter-Society Colour Council. He is also a delegate from the Chemical Institute of Canada to the National Association of Corrosion Engineers and the Technical Coordinating Committee of the Paint Industry.

He is a fellow of the Royal Microscopical Society and member of the American Chemical Society, Society of Chemical Industry and Optical Society of America. At the present time Mr. Fearnley is superintendent of the lacquer division and is chief chemist of the International Paints (Canada) Ltd.

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Saponification Value	196 - 200
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Saponification Value	192 - 196
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South Africa

By J. J. ANNEVELDT,
Smith & Walton

LIFE and behaviour of paints and allied protective coatings depends largely on climatic conditions, and consequently a paint technological contemplation should involve an investigation of local climatic conditions. Unfortunately, it is rather difficult to compare climatic conditions in South Africa with those in the United States as the author never had the opportunity of visiting that country.

South Africa sometimes is called "The Land of Sunshine"; in fact practically the whole year the sun is shining. Our summer starts about November and ends about March. The absolute maximum temperature during January for instance is about 90° F, whereas in June about 70° F. Climatic variations between different parts of the country are pronounced; for instance variations in temperature and relative humidity in Durban and Johannesburg (June 1947: Durban 63.4° F, Johannesburg 49.6° F—Durban 75% and Johannesburg 57%). Rainfall occurs mostly when summer and winter begin and is often of tropical intensity.

General Composition

IN South Africa, the average percentage of oil in paints, varnishes, enamels and modified alkyds is higher than in Europe, in order to eliminate the more severe breakdown of coatings due to sub tropical sunshine and humidity. Temperature variations account for the settling of paint products in the can, especially with second-grade quality products which are much in demand in South Africa. In this respect good results have been obtained with depolymerised rubber solutions, showing protective colloidial properties and with aluminium stearate. Pigmentation of white paints and enamels for exterior use is done with zinc oxide in low percentages in combination with titanium oxide and/or white lead and acicular fibrous extenders. Antimony oxide and lead titanate are seldom used. The use of acicular zinc oxide is becoming common practice. Owing to the severe sunlight, fading of greens and reds is pronounced. Green roof paints are mainly based on chrome oxide, because in addition to its light fastness, it is non toxic. This is important as in the country practically all the water is collected in storage tanks. Additions of aluminium powder, mica or vermiculite have been useful for improving the light reflective properties of roof paints. Wrinkling of synthetic enamels and varnishes occurs frequently. Additions of zinc napthenate and dipentene are used to cure this defect. Owing to the high relative humidity and pronounced condensation during the night it is common practice that after 3 p.m. no exterior painting is done in Durban.

Courtesy of Union of South Africa Information Office

Van Riebeick Statue, Capetown

Bad drying, poor adhesion and blistering are typical paint failures resulting from the above mentioned climatic conditions. Driers are used in slightly lower percentages than in Europe.

In mining areas the dust of the mines gathers in huge clouds which then are swept over the suburbs by rather severe seasonal winds. It is an established fact that contact with this sharp mine dust results in accelerated breakdown of paint films. Night frost or as it is called "Black Frost" sometimes causes a good deal of paint trouble in Johannesburg. Johannesburg is about 6,000 ft. above sea level and it is said that Stand oil is bodied there at about 580° F, compared with 600° F, in Durban. Wood oil is used, especially in paint for coastal areas; but owing to its quick drying and consequently hard film, less quantities are used than in Europe. Combinations of Wood oil and dehydrated castor oil are much in favour. Exposure tests have shown that long oil modified alkyds are the best vehicles for exterior paints in this climate, especially those modified with dehydrated castor oil and soybean oil. The average oil length on the solid alkyd used, ranges from 65 to 70%. Rosin and phenolic modifications are preferably not used. Exterior oil and enamel paints, especially white and pale colours, lose their gloss after a couple of months; chalking also occurs in early stages. Alkyd paints however, keep their gloss between one and two years and when properly pigmented, chalking is greatly retarded.

Lately the quantity of Marine oil used in paint products has greatly increased. Consequently the use of Wood oil and Oiticica oil is stepped up accordingly.

Preservation of oil bound distempers and dry distempers is another point which has to be watched carefully. Trichlorphenates have proved very useful in this respect. Wood treatment prior to building is done quite a lot in order to repel borers and white ants.

Raw Materials

Drying Oils: Linseed oils are all imported, mostly from America and Canada, they can be locally refined both by alkali and acid. Castor oil comes from the Belgian Congo and is dehydrated in the Union, but the quality leaves much to be desired. Marine oils are made locally in a range of different types by the Solexol segregation process. Quite a lot of research and development has been, and is still being carried out in this field. Oiticica oil is imported from Brazil, wood oil is becoming both scarce and expensive, but lately Tung trees are cultivated in the Union on a comparatively small scale. The possibility of using Sunflower and Passion Fruit oil in paints and varnishes has been investigated.

Natural Resins: Rosin, congo copal, shellac and manilla copal are mostly used but the latter is becoming more and more difficult to obtain.

Synthetic Resins: There are two plants in South Africa manufacturing synthetics—one vinyl copolymers and the other phenolics, maleics, modified phenolics, alkyds and urea formaldehyde resins. Both of them are working to some extent under licence of American synthetic resin manufacturers. Preliminary work on the manufacture of Silicon esters has started. It is reported that factories are to be established in Portuguese East Africa to produce Cashew Nutshell Liquid and paint materials from it, with a capacity of 50,000 tons a year. This will be achieved by using a new decortication process.

Pigments: Chrome pigments are manufactured locally, including the production of bichromate from local chrome ore. Red lead, zinc oxide and white lead are also being produced in South Africa—the latter is manufactured both electrolytically and by the Chamber process. Yellow ochre and red oxide are mined in certain parts of the country, but the subsequent treatment and consistency of the latter leave much to be desired. Titanium barium pigments have proved to be very useful in this climate.

Extenders: Whiting, barytes, magnesite and silicate type extenders are mined locally. Whiting is very white, but has poor opacity compared with English and French types, and moreover it contains sometimes up to 10% impurities. Barytes are sold in various grades of whiteness, but they are all rather coarse. Of the silicate type extenders, vermiculite is the most important and it finds more and more use in paint products. Lately development work has started on extenders of a type similar to asbestine. Local kaolin is of a poor quality; magnesite finds an increasing use in distempers, whereas whiterite has proved its excellent properties in paints here. It must be mentioned that as a whole the mined raw materials are inferior to the equivalent overseas types.

Solvents and Diluents: A full range of lacquer solvents is produced locally. Wood turpentine is practically not used in paints: white spirit, xylol and power paraffin all the more. Pine oil and dipentene are used to increase brushability and flow of synthetic enamels, to counteract wrinkling and skinning, and also for the preservation of emulsion paints.

Others: It has been tried by saturation of the double bonds in depolymerized rubber to get a weather resistant vehicle for roof paints, but exposure tests made so far do not stand up to the claims.

Woolfat is locally produced and finds some application in the paint field; glue and casein are of local origin. A potential growth in synthetic polymer industry based on the use of sugar derivatives can be expected. The annual production of sugar in Natal is about 600,000 ton. Some time ago the winning of sugar cane wax was dropped. Bi-col, a new thickening agent is produced in South Africa. It finds application in paint removers and emulsions.

(Turn to page 67)

THE AUTHOR

J. J. Anneveldt was born and educated in Amsterdam. His first position was with Avis Ltd., in Zaandam where he was engaged as a chemist in the plastic molding department. During the German occupation he worked as a forced laborer in the laboratories of Siegle Dyestuff Manufactures in Stuttgart and later with the I. G. Farbenindustrie A. G. in Krefeld-Uerdingen, Germany where he was engaged as a paint and lacquer chemist.

He returned to Holland in 1943 and was employed for four years with the Velada Chemical Works Ltd., in Delft and was paint editor of the Analyst. In 1947 Mr. Anneveldt accepted a position in South Africa where at the present time he is chief chemist at Smith & Walton in Durban. He has written many technical articles which have appeared in various Dutch technical journals.

Japan

By DR. SHINJI IWAI,
Tokyo Metropolitan Industrial Institute

THE AUTHOR

Dr. Shinji Iwai was graduated from Tokyo Engineering University in 1933. From 1933 to 1935 he worked with the Nippon Kako Paint Co., Ltd. as a chemist. Since 1935 he has been engaged in research work on paint and synthetic resins at the Tokyo Metropolitan Industrial Institute.

WOOD has always been an important commodity in Japan, and practically all wooden structures and objects were coated with Kakishibu (juice of astringent persimmons) or Urushi (Japan lacquer). However, it was not until 1860 that paint was introduced in Japan from England.

Demand for English paint grew rapidly as the Japanese adopted European manufacturing techniques and methods in constructing railroads, ships, bridges, buildings, etc.

In 1873 zinc white was first produced in Japan by *Shigejiro Motege,* and this is considered to be the first paint raw material to be produced there. Later, Motege was engaged in producing various types of paint pastes.

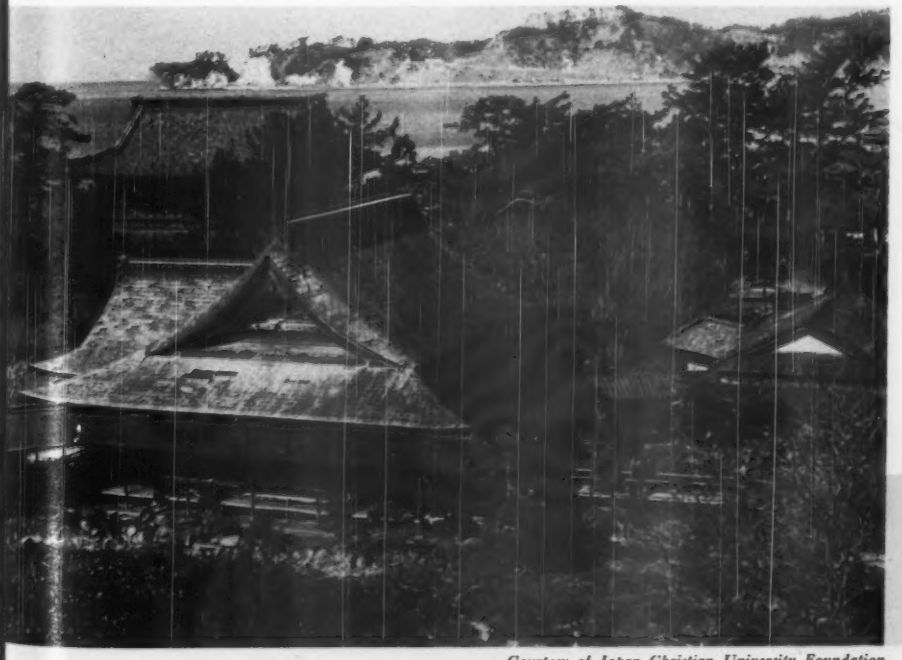
The ship building industry greatly influenced the development of the paint industry in Japan, and it is very significant that the first Japanese patent, published in 1884 by *Zinske Holta,* was concerned with anti-corrosion paint and its application.

World War I

DURING World War I, demands for all types of paints were very high. Since imports were drastically curtailed, it became necessary for Japan to produce all of her paints to satisfy domestic consumption. As a result, paint manufacturing plants sprang up over night. This easily met domestic demands and it was not long before Japanese paint manufacturers were exporting their products to China, South Sea Islands, and India.

Immediately after World War I, there was considerable interest developed in nitrocellulose lacquer which had been investigated and successfully produced in the United States. Its quick-drying characteristics, excellent luster and color stimulated the interest of paint manufacturers in Japan. Many companies began producing nitrocellulose lacquer using American processes and techniques.

About this time, another interesting development took place in the Japanese paint industry; the demand for specialty-type finishes. As a re-



Komei Temple, Kamakura

Courtesy of Japan Christian University Foundation

sult, manufacturers began introducing spar varnishes having fast-drying and water-resistant properties. These were formulated with tung oil. There also appeared on the market concrete paint, alkali- and acid-resistant paints, baking finishes for metals, etc. The development of nitrocellulose lacquer promoted the manufacture of synthetic resin paint which included alkyd and phenolic types. Thus, the paint industry in Japan took the form of a modern industry in scale and technique.

Although the Japanese paint industry greatly depended upon other countries for its raw materials, they were able to produce some very fine finishes with domestic materials.

A good example of this is Urushi (Japanese lacquer), which has been in existence since early history. It has been preferably used for wood, art works, domestic wood table wares, utensils and furniture. When applied to industrial art work, it shows unsurpassing beauty and excellent properties. Because of the decreasing output and subsequently increasing price of Urushi, many substitutes such as phenolic resin have been used for Urushi but most of them cannot compare with the fine characteristics of Urushi.

Raw materials imported were linseed oil, China wood oil, rosin, copal, dammar, shellac, gilsonite, carbon blacks and petroleum solvents. By 1939, Japan was able to produce paints equal in quality and price, except for a few types, to those of American and European firms.

World War II

THE advent of World War II brought a complete halt to all import of raw materials and since the paint industry was immediately engaged in the war effort, it became imperative for paint manufacturers to develop coatings for implements of war from available raw materials.

In this connection, considerable research was devoted to the study of coatings for light alloys, ship bottoms, and anti-corrosive purposes. It was discovered that benzyl cellulose was best for coating light alloys and therefore was used in aircraft coatings both as primers and enamels.

Cooperative efforts of biologists, ship building engineers and paint technologists, resulted in hot venedian type of coatings for ship bottoms. As for anti-corrosive paint, various kinds of pigments and metal powder were mixed for this purpose. Oil-resistant paints for coatings oil and solvent tanks were also developed during the recent war.

Because of the confused economic situation and drastic shortage of imported raw materials, the Japanese paint industry barely continued production immediately after World War II. However, in 1948, imports of drying oils and resins were permitted by the United States and it was not long before production began to increase substantially.

In 1939, output was the highest with a capacity of 110,000 tons. The lowest was in 1945, the end of the war. In that year production was only 10,000 tons. The annual production capacity in 1949 was 365,000 tons with a total number of 380 producng plants.

Plant distribution for areas:

Area	Plants (%)	Capacity (%)
Tokyo	44.5	31.0
Osaka	31.5	49.5
Others	24.0	19.5

Plant classification according to the scale.

Capacity per Mo.	Plants No. of	Capacity (%)
more than 1,000 tons	15	36.5
" 100	42	34.0
less than 100	232	29.5

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You will note that there are many plants which have a capacity of less than 100 tons per month.

Classification of paint products is as follows:

Name of Products	Product Percentage
Boiled oils	0.6
Paste paints	1.2
Mixed paints	37.94
Anti-corrosive paints	4.4
Putty	3.0
Driers	0.6
Oil emulsion paint	4.4
Bottom paint (for steel)	1.8
Bottom paint (for wood)	1.8
Varnishes	2.35
Synthetic resin varnish	0.6
Enamels	7.94
Synthetic resin enamels	1.20
Water paints	2.0
Spirit varnishes	2.0
Lacquers	6.0
Insulating oil varnishes	6.0
Insulating spirit varnishes	2.35
Mixtures	3.5
Thinner (includes stains)	10.32

Mixed paints rank among the highest, but their output depends upon the import of lineseed oil. The most remarkable progress which has been made recently is seen in the application of synthetic resin. Phenolic and alkyd resins which were studied before the last War, have been improved upon recently.

New Developments

As for phenolics, room temperature setting types have been used as Urushi-like coatings. Co-condensed products using melamine or other resins have been employed as a pale, hard and wear-resistant baking finish.

Excellent alkyd resins have been obtained by esterifying purified drying oil directly with glycerine and anhydride phthalic acid, or with anhydride maleic acid. Urea resin paints have prospered remarkably because of excellent raw material production. Production or ordinary temperatures drying type paints which are based on alkyd resins have also begun.

Many types of melamine resin paints, in which melamine is used partially or totally instead of urea, have been studied and some of them have been tested for high class art works. Recently, the production of vinyl acetate has been increased with consequent price decrease, resulting in the study and application of the material in coating formulations. Emulsion paints have been manufactured and have been substituted for mixed oil paints.

Extremely low polymerized vinyl acetate, blended with nitrocellulose has been greatly advanced because of its light color and desirable qualities. Because vinyl chloride is expected to be in mass production by the end of this year, co-polymers of vinyl acetates have been studied as bases for paint products.

Drying oils have been produced by the solvent extraction process which enables unsaturated fatty acid and its glyceride from fish oil or semi-drying oil.

As a substitute for glycerine, pentaerythritol is made from acetoaldehyde and formaldehyde, from which ester gum is produced.

For more than ten years the Japanese paint industry has been isolated from the United States and the rest of the world. Because of extreme shortages of important raw materials Japanese output has fallen drastically. Most plants are undergoing reconstruction and to this end considerable progress has been made. However, Japan must look to other countries, especially the United States for obtaining raw materials and technical skill in order that her paint industry may develop and progress.

"At least I don't have to worry about Nuodex drier supplies", said the Technical Director

"This raw material situation is certainly discouraging. Reformulations every day. Production slowed. Back orders piling up." *Ye Towne Drier* recently attended a Production Club meeting where he heard comments like these from every side.

Naturally, however, he was pleased when the technical director of a very large shelf goods manufacturer made the following unsolicited observation:

"I have plenty of trouble getting many of the paint ingredients I need, but you can tell your friends at Nuodex that at least I don't have to worry about drier supplies. If Nuodex naphthenates are short I can switch to the new, improved Nuolates without any difficulty—just a pound for pound substitution—and still be sure of dependable drying performance."

Old *YTD* said "Thanks!". And hurried back to Elizabeth to add the moral to this message: Rely on Nuodex for dependable driers.

P.S. Conversation . . . . . new developments . . . . . information—they all await you at Booth 53, Chicago Paint Show where Nuodex is your hospitable host.

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. . . UNITED STATES

(*From page 13*)

Technical Advisory Committee of the *Federation of Paint and Varnish Production Clubs* was first used in an advisory capacity by the *Engineer Board;* for the purpose of solving some camouflage paint problems which later developed into an advisory committee, in technical capacity, for all of the Armed Forces. Painting problems were presented to us of every nature; it was essential that they be quickly solved and the paint chemist did so. Out of this grew certain information that was later transferred to our domestic economy. The paint chemist came fully into his own in that period. While we know that he was essential before that time, his full importance was not fully realized. Today it is difficult for anyone to be in the paint business without the aid of a chemist. Coatings today are a development of the ages, but the improvements of the last decade are absolutely astonishing. Paint is an engineering material; its development is the function of the chemist!

The second most important, and one that is very likely to ultimately be the most important, and is the logical next step in the utilization of technical knowledge is the salesman of the future. As with the chemist of yesterday, his importance was recognized in the last decade, but the use of such chemists in a sales capacity was started with the industrial finish manufacturers producing "tailor made" articles realizing the necessity of a chemist that knew how the material was developed and what it would do, and that he should be the person who contacted the customer. Today, most of such chemists are in the capacity of technical advisors to the sales department and many companies would use technical men only as salesmen if there were plenty of technically trained men available. Therefore the ones that are capable of entering the sales department must be "spread-out," but the future holds great promise for the use of these technically trained men in the sales department. After the industrial finishing manufacturers, the next potential place for the technical trained salesman comes in the industrial maintenance field, and as the knowledge of the use of our products increases, the necessity for technically trained men in the sales department is obvious.

Truthfully, the paint industry of this past decade in the United States has changed to a highly technical, and specialized field, with many newer raw materials available and the necessity for developing new and improved coatings, constantly with us. The coatings of tomorrow will be even better and specially designed for every type service. Great promise is held for this industry in the coming decade.

. . . ENGLAND

(*From page 18*)

varying pigments were compared for behavior under outside and accelerated weather conditions, using standard apparatus and exterior exposure at 45° facing south.[4] For example, maelic resin alkyds with zinc, titanium and zinc-titanium-antimony showed chalking at 200 hours (accelerated weathering) but no checking and cracking until 1,000 hours. Under outside exposure, the same paints chalked in six months, but checked and cracked in six

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months and eight months respectively. If there had been correlation between A.W. and N.W. there should have been no checking and cracking for 30 months outside.

It was the above type of discrepancy which started a comprehensive investigation by the Paint Research Station in which water, ultra violet and temperature treatment were varied separately and simultaneously. Some curious results were observed. In some cases certain varnishes, durability was actually increased by increasing the intensity of ultra violet, due to the enhanced baking effect obtained. The overall speed of breakdown was increased by increasing the time during which the film remained wet. On the whole, however, no better correlation between A.W. and N.W. was obtained than before. It was only when the intensity of oxygen treatment was increased that significant results were obtained (factor 4 above). At first, ozonized air and hydrogen peroxide were tested with the spray water and by actual immersion with almost negative results.

At the suggestion of the Inter Service Sub Committee on Accelerated Weathering, the effect of increasing the partial pressure of oxygen was investigated. The results obtained were encouraging and significant. By increasing the oxygen pressure up to 100 lbs/sq. inch, rapid embrittlement and cracking throughout the film was obtained. In some cases, the film became sticky and even fluid, showing that this factor had been increased out of proportion. At 25 lbs. partial pressure and upwards, however, several cases of good correlation were obtained. Paint systems with linseed oil primer, (lead based), linseed oil undercoat (zinc oxide), and zinc oxide based oil paint show that by using a slow cycle accelerated weathering so that the film remains wet for a longer time together with increased oxygen pressure (25 lbs. sq. inch), the type of breakdown is very much closer than that obtained with slow cycle alone, or increased ultra violet alone, or "normal" accelerated weathering.

Much work remains to be done. But there is no doubt that the partial pressure of oxygen has been established as the critical factor in accelerated weathering in this country. It is more than likely that different partial pressures will be necessary for different climates and different paint systems to get adequate correlation. This is a matter for careful empirical experiment. In one sense, this work may be considered to be an extension of that of *Slansky*[5] who established that *decrease* of partial pressure of oxygen during drying of linseed oil films *increased* water resistance and durability.

Application

OVER the last few years, there has been a continual interaction and flux, between formulation of industrial finishing coatings and application. On the consumer side, the aim has been quicker production, greater output and enhanced standard of finish and durability. This would appear to be a contradiction in terms. How to increase output with the same floor space and yet improve quality? This is the same quality-quantity problem which applies from the fundamental sciences to the sales promotion forces. Only by changing the qualitative basis of production can output be increased without deterioration of quality—this is on the assumption that production is already on a high level of efficiency.

Apart from those specialized products like cables or cans on which organic coatings are extruded or cal-

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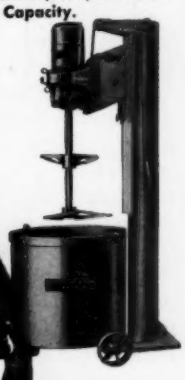

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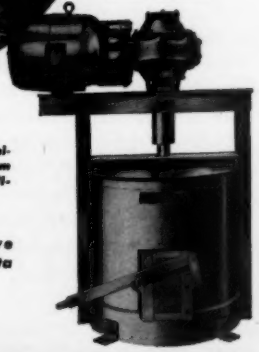

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endered, the spray gun has had almost a monopoly on the industrial finishing side. Within the last few years, however, great inroads have been made by dipping processes, particularly when combined with conveyerized baking operations. In almost 50% of the large industrial undertakings surveyed by the writer both in this country and in the States, dipping has replaced spraying for the priming coats on metal.

The convenience and economy, with low labor costs and saving in raw materials have been potent factors in effecting the change. These factors even affect the question of industrial design of commodities. There are several examples of commodities in which functionless ornamentation has been ruthlessly eliminated to facilitate dipping. More and more one can find that the engineer, industrialist, designer, chemist and paint manufacturer sit in at the birth of a new commodity be it perambulator or vacuum cleaner.

One of the best examples of the joint solution of a difficult dipping problem, is the *Rotodip* process for automobiles in which Great Britain leads the world. Designed and completed by the *Carrier Engineering Company,* it nevertheless demanded the co-operation of specialty companies in different fields and with no financial interconnection—one of those many cases where private enterprise must be co-operative in order to solve its acute problems.

What was involved? First, there was the cleaning, preparation and passivation of the metal surface of the complete body. Here the engineer adjusted his design to the minimum requirements of the preparation specialities (*The Pyrene Co., Ltd.*). The size of the tank and speed of forward rotation of the body were governed by the maximum speed of attack of the cleansing and phosphating solutions. A minimum of 30 seconds contact of every part of the body with the Bonderizing solution was essential to give adequate phosphating before washing and passivating.

From thence, the engineers and paint manufacturers had to make mutual concessions in order to solve the question of immersion, drainage, even coating, flashing off, and final baking of the priming coat. Finally, there is no doubt at all, that the design of the body was strongly influenced by the imperative necessity of even coverage and easy drain off during the seven separate dipping operations involved.

Fig. 2 indicates the method of mounting the body and its progress through the plant. *Fisher Ludlow* were the first people to install the plant for priming *Standard Vanguard* bodies. Since then, the *Nuffield* organization and *Austin Motor Company* have followed suit. We understand that plants are projected in Scandinavia, France and the States. The total time through the plant is under two hours with bodies following each other at three minute intervals. The operations are:

1. Degreasing with emulsion type detergent at 180° F.
2. Rinse with cold, followed by hot water.
3. Bonderizing with standard acid phosphate solution at 170° F. Total time in and out of Bonderizing bath 7 minutes. Minimum time of contact with Bonderizing solution, 30 secs.
4. Hot water rinse.
5. Dilute chromic acid rinse, followed by dust free ovens.
6. Priming dip coat (at 160° F.), draining, flashing off, then baking at 300° F. for one hour.

The type of paint used is a medium oil alkyd and the interesting feature is the small amount of drainage of paint (almost negligible) and the smoothness of coat obtained. The automobile body is, of course rotated continuously about the balanced spit throughout its travel in the plant and final release after baking of the primer. It is interesting to note that perfection of a sturphorizing primer would cut out the necessity for three dips and make the engineer think again.

On smaller commodities, it is interesting to note that dipping has now encroached on the field of the actual finishing coats. The largest manufacturer of perambulators and small pedal cars in Great Britain now gets an excellent finish by dipping only on a large proportion of output. Several of the largest manufacturers of automobile accessories now use the Ransberg electrostatic-detearing process to obtain a first class dipped finish.

Tumbling Finishes

THE achievement of first class finishes by tumbling or rumbling on small articles, is still in the rudimentary stage in this country. Apart from buttons and small metal corners for attached cases and one or two similar articles there has been no real organized attack on this problem. Only a handful of manufacturers, with a long background of very painful empirical experience in this field, have achieved any substantial success. What is really needed is an exhaustive practical investigation by the Paint Manufacturer, using horizontal, inclined, and "Polymotion" barrels and trial work batches of the customers' products. In this way there is no doubt that tumbling could be much more widespread and solve a lot of finishing problems. Over the last twelve months the writer has been responsible for the introduction of tumbling on wooden handles, to most of the large scale brush manufacturers in this country. The process, so far, is only successful for moderate finishes or priming coats, but the saving of labor and material is quite startling. e.g. One and a half pints of special short oil alkyd cellulose combination is poured over ten gross of 6″ brush handles in a horizontal tumbler and run for 25 minutes. The handles come out smooth and dry.

On metal the problem is more difficult. Successful tumbling on small metal parts has been achieved with traditional long oil Congo combinations, but a minimum of two hours baking time is essential. Urea alkyds and melamines could be used if the sticking problem could be overcone. The problem is an empirical one. If the parts are allowed to rotate in the tumbler till touch dry, they then mark each other. If they are baked while still wet, they stick together in a solid mass. Between the two extremes is a point of tackiness at which the parts will not stick, and yet will flow out in the oven sufficiently to cover tumbling marks. The angle of the tumbler, the speed of rotation, the weight of the parts, and the type of finish all have to be considered before success can be achieved. The writers organization is setting up an experimental department for the solution of just such specific problems. Here are a few practical hints from the writers experience on a cellulose air drying tumbling enamel.

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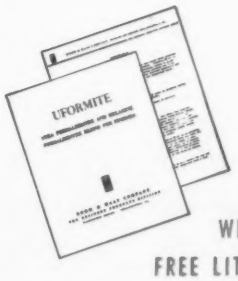

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Hints for tumbling

1. Excess of paint is fatal. Surface area of small parts should be calculated and paint added at the rate of 300 sq. feet/gal. for cellulose and 400 sq. feet per gal for synthetics.
2. Speed of rotation of barrel should lie between 20 and 45 revolutions per minute depending on weight of article.
3. Enclosed barrels with horizontal axis should be over half full of articles. With heavy articles it should be three quarters full.
4. Actual pigment content of tumbling enamels should be at least 300% greater than normal spray enamels and viscosity should be as low as possible.

Formulae

Cellulose Tumbling Enamel P. O. Red

516 lbs. 1/8 sec. nitro cotton
250 lbs. hard maleic resin
150 lbs. non drying alkyd.
15 gal. D.B.P.
10 gal. acetone
40 gal. butyl acetate
15 gal. butyl alcohol
5 gal. butyl cellosolve.
54 gal. toluol

Grind 6 cwts. toluidine fast red in above medium (ball mill) giving a yield of approx. 250 gallons. Used for wooden bottle tops in which were fixed cork inserts.

White Synthetic Tumbling Enamel

320 lbs non drying alkyd (Xylol 50:50.)
400 lbs urea alkyd.
30 lbs dibutyl phthalate
10 gal white spirit
15 gal xylol

Grind in 4 cwts Rutiox giving about 110 gallons Ball mill 48 hours.

Spraying

WHILE the above brief remarks indicate the advances which have been made in dipping and tumbling, it should not be assumed that the technique of spraying has remained static. Over the past few years three main developments on a substantial scale which have helped to maintain spraying as a major method of application of organic coatings are:

1. Automatic spraying on large and small articles.
2. Automatic spraying combined with electrostatic fields.
3. Hot spraying.

The first two have been confined almost exclusively to metal articles, and the third almost exclusively to the furniture trade and wood finishing, generally. Some 30% of the furniture trade has been converted to hot spray, due in the main to simplification and improvement on those pioneer plants which were produced before the war. In addition the paint manufacturer with more and better resins at his disposal, has been able to formulate improved lacquers adapted to the new tools. In addition to this, an interesting small spray plant in which no compressed air is used, with electrically operated turbo propellers as the sole atomizing force might be of considerable interest in the future. One interesting example of electrostatic spraying applied to wooden articles is its use on tennis racquets with a consequent saving of 60% of lacquer consumption with 75% labor reduction.

In conclusion, perhaps a word should be said on the potentialities of the air drying and low baking

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catalyzed resins. Their properties are well known on both sides of the Atlantic. In Great Britain they have not had the reception to which their excellent chemical resistance, build and durability would entitle them. Nevertheless, it is gratifying to note that on the North East coast of England, the writer saw the birth of one of the largest factories in the world to use this type of resin as a furniture finish. This factory is equipped to turn out over 10,000 suites of furniture per week. The completely conveyorized finishing plant is designed for forced drying of the cellulose sealer for thirty minutes, followed by the usual shading and matching operations. Finally the finishing coat is a catalyzed straight urea formaldehyde resin baked for one hour at 140° F. in an atmosphere conditioned to 45% humidity to prevent warping of the timber.

This plant has now been running at partial capacity for some twelve months, and its success will undoubtedly stimulate the use of such resins throughout the finishing field, in the near future.

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. . . BELGIUM

(*From page 20*)

cotton fibers on the surface. Then gently blow on them and note the time when they are removed; this is state 2 (dust free).

5—At given intervals (say 20, then 5, then 1 minute), drop a few cotton fibers on the surface and apply the rubber disc of the Siccometer on them (previously adjusted at 300 grams of pressure). Then blow gently on the fibers; when they are blown out, state 3 is reached, note the time (tack free).

6—Adjusting the Siccometer at 500 gr., apply it as stated in section 5 above, but twist the column 90°. If it does not mar the coating, we have reached the state 4 (solid); note the time.

7—Measure the hardness after a given time and note the result as well as the time.

When reporting the above observations one can draw practical conclusions from the figures and after a very short time, all conditions remaining the same, one can get reproducible results.

Although this method is not yet perfect, it has given the author enough satisfaction for a first publication.

References

(1) If we had used a porous base instead of an impervious one (wood for example instead of steel) we could have noticed that by this time the gloss and smoothness of the varnished surface would be greatly impaired, the underlying coating being more or less absorbed by the pores of the wood. This would never happen if the whole coat was in the same state as the upper surface.

(2) The Siccometer is made by SCITEC, Blois van Treslongstraat, 36, Amsterdam, Holland.

. . . FRANCE

(*From page 23*)

prevalent. One might ask "What about reconstruction?" It can be said that in areas where war devastation has occurred, rebuilding is just beginning, and it will be some time before paint will be used in vast quantities.

The National Federation of Paint, Varnish and Printing Ink Manufacturers has recently established a Commission called the "Commission for Joint Propaganda." The purpose of this Commission is to increase the use of paints by pointing out their importance.

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. . . SWITZERLAND
(*From page 27*)

The order of magnitude of this phenomena decreases with increasing temperature since the secondary binding force is weakened by an increase in temperature. Thus, under such conditions, the mechanical strength of the matter decreases and this is indicative of the temperature-dependency of the system.

As soon as very strong secondary forces, or even primary valence forces become active, the formation of an elastic framework appears. With these developments, there is a corresponding decrease in the solubility and fusibility of the material, and then a system is attained which is no longer dependent on temperature.

As an example, such two-phase conditions can be shown experimentally with caoutchouc. By careful solvent extraction, the solute is free and after the solvent has evaporated completely, the material becomes a plastic mass. But, immediately after the extraction, the material is an elastic gel which is insoluble. Systems which do not have a plastic phase can be plasticized by the addition of a substance which will impart a certain degree of flexibility to the film. In this case, a certain reverse in the temperature reactivity of the film may be obtained. This "two-phase" conception is further strengthened by the discovery that optical factors in regard to the study of tensile characteristics are different for the plastic and for the elastic phase.

Effect of Moisture

MOISTURE is one of the most important factors in the destruction of coating films. It would, therefore, seem desirable to use films which do not swell at all. However, on the other hand, it is necessary that the coating film has a certain minimum number of functional groups in order that it may adhere to a non-porous substrate. Most of these groups are of a polar nature and, threfore, capable of attracting water molecules binding them in the form of "solvation spheres." This may allow migration to take place and thus be the cause of diffusion.

The swelling capacity consists of a continuous absorption of fluid and is accompanied by an increase in volume. This can therefore be seen as an intermediate state between solubility and insolubility.

There is a difference between limited and unlimited swelling. Since unlimited swelling is a transition state as compared to the dissolving of solid matter, it would be undesirable to have such a characteristic in a coating film.

Swelling and film permeability are influenced by colloidal or macromolecular condition. Generally, both decrease from a certain point downward as the molecular weight increases. Cross linking decreases the swelling capacities.

The attraction of water by colloidal substances occurs in two different ways. In one case, the water molecules are oriented on the surface of the micelles and is described as "inter-micellular" swelling. If, on the other hand, the water molecules penetrate into the micelles themselves, the effect can be considered as "intra-micellular" swelling. Both types differ in their characteristic vapor-tension curves. This is shown in Figure 5. From this, a number of practical aspects could be followed and considered, but this is beyond the scope of this paper. However, there are two conclusions that can be derived from the above assumptions: (1) The intra-micellular swelling depends on the volume of micelles, and (2) inter-micellular swelling depends on the number of effective surfaces.

It is important in practice to know what effect moisture has on coating films. Coatings which do not swell are not affected by moisture in regard to their mechanical properties, as compared to those which do swell. Figure 6 is a stress-strain curve of a tung oil varnish, the film of which has been exposed to various humidities. Measurements were made when equilibrium in the swelling action was reached.

In this particular case, the moisture which was absorbed into the film acts in much the same way as a plasticizer. In both instances, a decrease in the secondary binding forces is observed. On the other hand, an increase in the energy of the tung oil film can be represented by integral of curves which are shown in Figure 6.

In this respect there is not much difference between the various humidity contents. Therefore, plasticity is directly proportional to the moisture content of the film, whereas, in the case of breaking tension, water has the opposite effect.

Closely related to swelling capacity is the water vapor permeability, and this is a very important factor in corrosion-resistant coatings.

It has been found that there is a linear relation between permeability and time, and is directly proportional to the relative moisture content of the surrounding atmosphere; that is the gradient of the existing moisture condition. See Figure 7.

Polar Light Studies

AMORPHOUS, transparent materials are known to be double refracting as soon as they contain areas of internal stress. In the case of a coating film, this may be an indication of the beginning of destruction of the film. This is shown in Figure 8. All along the cracks there appear zones of double refraction. Certain stress conditions are more visible under circular polarized light. Figure 9 shows the manner in which the lines of interference at the border area between the plastic and elastic form changes. These lines are characteristic in the presence of stresses and appear where there are micelle bundles with low degree of orientation. On the other hand, where there are border zones with micelles of a higher degree of orientation, para crystalline groupings may form. Finally, observations in polarized light can give indications of stress conditions as they appear when pressure is applied on a film. See Figure 10.

It has been shown by a number of examples that the application of modern research methods can further the progress in the field of coating technology. Different structures are being obtained from different film-forming substances, and it will be possible to influence the development of these structures by accurately investigating all the factors which cause their appearance.

From the knowledge of film structure, important conclusions may be drawn in regard to film characteristics and their behavior under practical conditions. Usually, it will be necessary to make compromises between the various properties in order to avoid a condition where too much of one would bring about an undesirable feature in the film. Here again, it is important to know the actual structure.

. . . NETHERLANDS

(*From page 30*)

flour, straw and, last but not least, coal. Up to now the advantage of a chemical industry, is the introduction of new materials to the paint manufacturer resulting from basic research. What is offered to us from abroad has already been investigated.

Technology

YET the technology of paints as such in the Netherlands is in a constant process of development. Some 300 trained chemists, one fourth of them university graduates, take part in it. Most of these were organized since 1932 in the "*Section: Paint, Bitumens and Plastics*" of the *Association for the Knowledge of Materials* founded in 1926 by the late *G. L. Tegelberg*. Most paint firms have well equipped laboratories, and a special institute, which is part of the national *Applied Science Development Organization, the Paint Department of the Central Institute for Investigation of Materials* (*CIMO*) at Delft, acts as a contact and research center to these. There is much contact in the field of application and testing methods between these paint laboratories and the research laboratories of some of the bigger Dutch companies, like the *Dutch Railroad Co.*, the *Shell Oil Co.* and the *Philips Glowlamp Works*. There are committees of paint technologists from several interested firms, which since 1943 work together with the *CIMO, Paint Department*. They have worked out a number of recommendations for analyses and test methods. These methods are partly new. These committees began their work during the German occupation, when everyone had time for work that was not related to the production needed by the Nazis. Nowadays everyone is fully occupied in rebuilding our national economy, which is still very prevalent. Part of the investigations decided upon by the committees is carried out by the Paint Department of the CIMO, and part is divided among the members to be done in their own laboratories. The Paint Department CIMO has issued over 60 useful reports since 1942.

Testing

IN discussing the work on paint technology in Holland, one is apt to ask, why we must develop our own line of attack; why not follow our big brothers overseas, who, on a whole have to deal with the same technical problems and are generally able to attack them at a much larger scale? Why, for instance, should we try to make our own test methods? Do we not believe in A. S. T. M., B. S. S., etc. Yes, we do, but we think that new points of view as to testing are possible, and that, as a matter of principle, the tradition of standardized testing should be reviewed and changed from time to time. We believe that in a country like ours, where things are done on a smaller scale than the U. S. A., but where tradition, education and technical skill give possibilities for developments on an advanced level, progress can be furthered and profitable business be developed out of a critical reconsideration and a scientific analysis of generally accepted standard practice.

Now take the study of the mechanical properties of paint films. Is it possible, to analyze these properties and to determine constants from which to derive the practical mechanical behavior of paint films? First of all we can determine tearing strength and elongation at the break points for separate paint films. To do this we tried out several well-known devices

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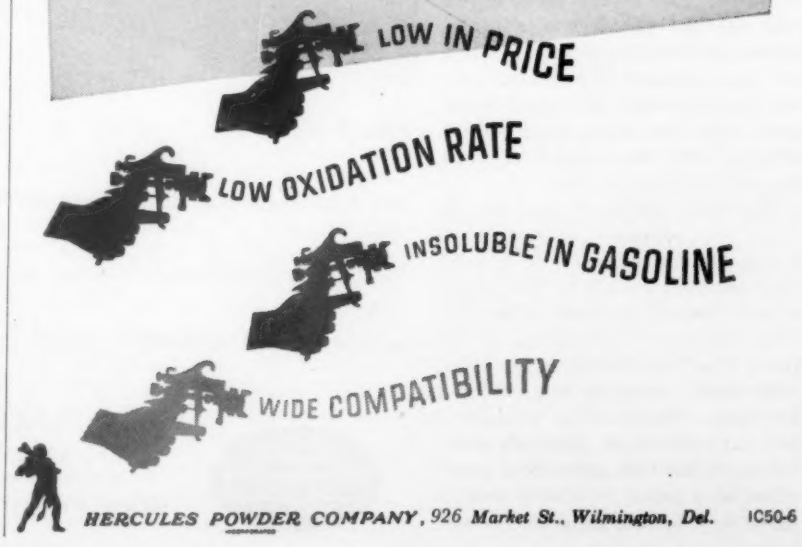


HERCULES POWDER COMPANY, 926 Market St., Wilmington, Del. IC50-6

for making detached paint film, chose a doctor-blade system, and one of us conceived a mechanical device to measure the thickness of paint layers in a very accurate way without compressing the paint with the micrometer (see fig. 1).

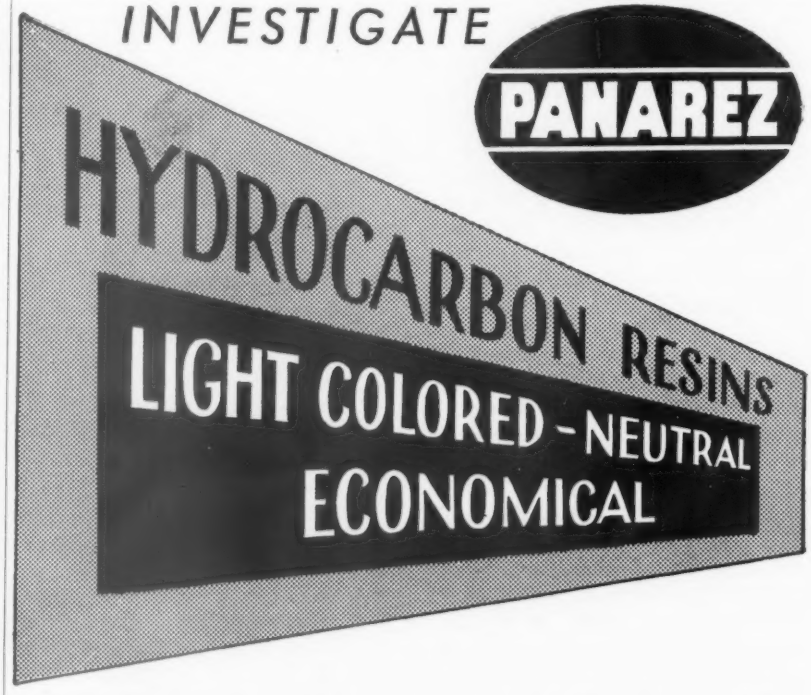
We then made an instrument, allowing the elongation of a film at a fixed rate irrespective of its stress-strain curve (fig. 2, 3). In this way, the testing of loose paint films was made easier, and a number of investigations with several types of paints and lacquers were carried out. The divergent influence of temperature on stress-strain relations of oil films and thermoplastic films can be clearly demonstrated. Out of this first step which did not bring basically new facts as compared with work done elsewhere, a program is now in the course of development, on which the deformations of paint films by small forces and the forces induced by small deformations will be studied.

But, as is well known, adherence of films to the surface is as important in regard to the mechanical behavior of paint films as their stress-strain curves. The problem of adherence was studied, a great number of known methods for its determination were tried out, besides a few original ones, but we did not succeed to determine the adherence. The new method of *Green and Lamattina* (Interchemical Adherometer), which, too was studied by the CIMO, gives values for adherence by a not too simple extrapolation and subtraction. This method is an indirect one, and it is not quite sure, that true adherence is measured. One of the methods we tried out (fig. 4), gives an approximation of adherence, but it succeeded only for a number of paints on iron, and here a certain deforming in the paint film also takes place, which adds up to the force used to separate the paint and the surface.

We think, therefore, that up till now, the adhesion or interfacial energy between paint and the painted body generally cannot be determined as such, but only in combination with other mechanical properties of the paint film, like hardness, viscosity, yield value, breaking strength, and brittleness. The problem however is of great importance, especially in relation to the rust preventing properties of a paint. It is only from a perfectly adhering paint film, where the interfacial free energy is very low and where every part of the surface is covered without intersections that complete rust prevention can be expected on the long run.

Because of these basic difficulties with the determination of adhesion, recourse has to be had from very practical methods. The Ericson test seems very arbitrary and is too complicated to enable the drawing of exact conclusions. Bending tests and impact tests are preferred by us. The simple device of dropping a number of hard objects (for instance 20 standardized nuts from a certain height on the painted surface (inclined 45°) and measuring the damaged spots on the surface gives usable results.

The exact hardness of paint films is very useful to know; because of the difficulty of making hardness tests on layers 25 microns (1 mil) thick; determination of this property is not yet in general use. We found it impossible by using a differential capacity device to measure indentations. This was made with a Vickers diamond. 5-10 microns deep within 0.1 micron (fig. 5). As regards wear tests, we found the apparatus of the Bell Laboratory a very useful device to measure wear produced by the impact of sharp and hard materials (i.e. sand). If, however, wear is affected by a rubbing action of soft materials like textiles or leather, we think the mechanism of wear is of a quite different character. In this



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case wear can be measured by rubbing with cotton fabric in such a way, that no dust is gathered on the surface tested (fig. 6).

These details concerning our approach to the mechanical properties of paint are given here only to illustrate the way in which one particular problem was attacked by our paint laboratories. Tests were also formulated and tried out on hiding power, reflection, chemical resistance, water permeability, absorption, etc.

Paint Analyses

AS to paint analyses, *Dr. C. P. A. Kappelmeier,* must be mentioned, for besides his well known work on the determination of phthalic acid in alkyds, he developed many other methods for the identification and quantitative evaluation of a number of resinous substances and their components.

One of the functions of analyses in paint technology is to induce manufacturers of resins and polymers to give away the exact composition of their product. This function is very beneficial, because the tendency of such manufacturers to protect themselves from their competitors by not telling what their material really is, is on the whole a serious drawback for the progress of paint technology. A country that buys part of its paint materials from outside, suffers more from this drawback than a big country where paint and resin manufacturers can work more closely together. We in Holland are therefore very grateful for every new achievement in the art of paint analyses!

. . . DENMARK
(*From page 33*)

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rapidly that it was necessary to move to larger surroundings, and S. Dyrup & Co. has therefore constructed its new plant north of Copenhagen, in a place, where the separate factories are placed between green lawns and flower beds, which is considered as something unique. The firm must absolutely be characterized as the most beautiful situated chemical factory in Scandinavia, and presents the ideal for the paint and varnish industry. S. Dyrup & Co. has after the last war started a large plant in Portugal, and has reached an important placing in the Portuguese home market.

A. Stelling is another of the larger Danish concerns within the trade. It is one of the oldest in the country, and has through a solid and steady development obtained a firm position among its clients.

A/S Danske & Lakfabriker and *O.F. Asp* are two other factories, producing large quantities of all the important paints.

Several other factories, e.g. *A/S Kasika, Hempel's Shipspaint Co., Krause A/S, "De Danske Sprængstoffabrikker", a.o.* have specialized in various lines in order to fulfill the demands of the Danish community.

Most of the mentioned firms have an extensive export, especially to the other Scandinavian countries, for example ship paints from *Hempel,* which also are produced by associated plants abroad, and the leather colors from the *A/S Kasika.* Denmark has had great success with its export of printing inks, a chapter which, however, falls outside the scope of this article.

Raw Materials

AMONG the suppliers of raw materials in Denmark is found one factory, *A/S Smelting,* of white pigments. It is located just outside Copenhagen in the vicinity of Kastrup airport, and its main product is zinc white, which is prepared by the "Smelting-process." Zinc is melted, distilled and oxidized in the same room. *"Hygæa"* has specialized itself in the distribution and export of iron oxide pigments and earthen colors from imported raw materials.

A/S Polyplex was established about three years ago for the production of synthetic resins and plastics. This firm specializes in the manufacture of alkyds and modified phenolics. They export many different types of alkyds which are similar to those produced by American firms.

The large Danish oil factories produce linseed oil and other drying oils, as well as glycerine for the paint and varnish industry, but the actual boiling and preparation of these oils are made in the varnish industry itself. Oil flax is now grown in Denmark in such large quantities that the needs of the industry can be easily fulfilled.

Research

LAST, it is worth mentioning that the Danish paint and varnish industry after reaching its present high standard, has found it expedient to establish a cooperative research laboratory (*Central Research Laboratory of the Danish Varnish and Paint Industry*), which recently has moved to new and larger facilities where has been installed the latest and most modern equipment obtainable for the control and testing of paints and varnishes. The leader of the research laboratory, *H. K. Raaschou Nielsen,* has for many years operated in American varnish laboratories, and has there received a training, which has proven to be of great value to the institution and himself in his present position.

A "Danish Varnish & Paint Chemists Association" has also been started for some weeks ago, with the intention of affiliating it with the international paint and varnish associations.

. . . GERMANY
(*From page 41*)

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very short space of time. It is merely necessary to combine the two reacting materials shortly before the application of the varnish; the films being formed by the chemical reaction itself. The character of the films produced can be varied within a wide range by suitable qualitative and quantitative selection of reactants.

Post War Developments

ALL these developments commenced during the last war. They slowed up considerably in 1945; most of the developments during 1945–1948 being of theoretical importance only. Most of the raw and finished materials employed during that period were substitutes, forcing the paint and varnish industries to fall back upon the old prewar oil raw materials such as linseed oil, boiled oils, stand oils, etc. In view of more than 30 years of experience with these materials (especially by the German State Railways), high grade paints of all descriptions including anti-rusting paint, insulating lacquers and varnishes, etc. were produced. There has been considerable advancement especially with regard to the controlling and checking methods for produc-

tion and laboratory use. Valuable mechanical and analytical methods were developed by numerous experts based particularly on the pioneer activities of *Dr. Hans Wolff* and his co-operators, *Dr. C. P. A. Kappelmeier,* etc., the most important of which have been described in Dr. Zeidler's most recent book:—*"Laboratoriumsbuch für die Lack- und Farbenindustrie."*

Since 1948 conditions in Germany returned very much to normal again. Synthetic resins again became important raw materials, the straight natural oils again gave way to the modified natural oils, etc. Much attention has also been given to the development of varnish testing apparatus, not only for the testing of varnish and paint products but for the development of new raw materials and products. This latter fact is a very new feature in development. The paint and varnish industries do not throw new products on the markets as they used to do before the war, but only after most careful direct and comparative testing with modern apparatus. This is one of the reasons why scientific progress in these industries appears to be somewhat slow in comparison with prewar conditions. This applies, for instance, to the styrenated alkyd resins, the conjugated oils, and numerous other substances derived from the synthetic industries.

In 1949, *Professor Dr. Joh. Scheiber* pointed out before the *General Meeting of the German Society for Oil Science* that the basic principles underlying paint and varnish production are much more complicated than those of synthetic materials or raw materials. For this reason only the most strict and rigorous scientific testing of new materials and products previous to practical introduction will yield satisfactory results and help to advance the paint and varnish industries. In May 1950, a Standard Committee for paints and varnishes, including practically all important chemists and technologists, was formed. The chairman is *Dr. Felix Wilborn.* This committee has already commenced to organize scientific research and control testing. This includes a practical index value for all paint and varnish raw materials used and being introduced from time to time. Much of this work is based on valuable control and testing procedures used in other countries, especially the United States. Results have already been achieved, a typical instance being a new consistency scale system ranging beyond the entire range of viscosities determined by the air-bubble test, including linseed oil diluted with white spirit on one hand and lithographic varnishes of higher viscosities on the other, (see Fig. 1). This set includes thirty steps and does not contain any mineral oils but entirely new non-structural viscous fluids entirely free of the ageing phenomena characterizing mineral oils. It is not necessary any longer to test consistency of substances by three different scales utilizing ascending air bubbles.

Considerable success has also been attained with infrared drying processes of varnishes and lacquers. New drying ovens have been developed operating either on the complete dark-ray system containing a certain proportion of rays within the visible section of spectral light. It has been possible with these ovens to reduce the drying period of bodies such as bicycle frames to five minutes. Considerable advances have also been achieved in the boiling of oils to stand oils of highest quality which among other advantages have considerably improved esterification process control.

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. . . ITALY

(*From page 45*)

at low prices, and even sell them abroad. Lack of painting during the war and the present reconstruction program have caused a great demand for all types of paints. Of course, we are concerned with quality rather than quantity, and in 1947, a meeting was held in Paris, the main purpose of which was to discuss improvement of the quality of all paint products. This was attended by representatives of all European nations.

I have tried to give you a clear picture of the Italian paint industry in general. I can only add that the Italian industry can look forward, and it is my belief that the future is bright. Every new product in our field is the result of years of work in our laboratories. Our industry is a very fascinating one for there is no end to our research.

. . . CANADA

(*From page 47*)

Vinylite finishes are becoming more common place. Many types of products of this class are available. Emulsion paints based on vinyl resins for the interior finishing of apartments and dwellings are being used in greater amounts as time goes on. The advantages claimed for these finishes are said to be great over the regular type of flat wall paints. Some difficulty was experienced when they made their appearance a few years ago, but continued development work has ironed out most of the kinks. Improvements in the stabilization of vinyl emulsions paints have been made by the research workers at *Shawinigan*. The use of non-polymerizable surface tension depressants together with a small amount of a hydrophilic colloid during the polymerization of the vinyl ester in an aqueous dispersion are claimed to produce a more stable emulsion.

Paints for metal protection based on vinyl resins have become quite popular during the past couple of years. A wash primer is extensively used for different types of metals which, in many cases, created finishing problems before the introduction of this vinyl based primer. From this development other primers and finishing paints have been formulated which are showing very good service in extremely tough exposures. Particularly is this so where resistance to salt, mild alkalies and weak acids is required. Development work is still being conducted in an attempt to broaden the field of application.

The formulation of house paints has changed materially during the past few years. It is no longer possible to grade the paints on a chemical analysis but exposure tests are required before any degree of accuracy can be obtained as to what constitutes a first grade or a second grade paint. The advent of such pigment as titanium dioxide has changed the standard formulations. Considerable work has been done on exposure tests of house paints having varying pigment volume concentrations and different reinforcing agents in the vehicles. Most house paints today show a somewhat higher pigment volume ratio than 28% and in practically every case titanium dioxide in some form or other is found in the formulation. Basic lead sulphate is being used to a greater extent to replace the basic lead carbonate. An ever increasing amount of bodied and blown oils, and in some cases reinforcing varnishes, is finding its way into house paints. These changes result in harder paints with higher gloss and are giving satisfactory service under the extremes of the Canadian climate in the majority of cases.

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COMPARATIVE TEST DATA

	Porcelain Balls	"Borundum" Media
DURABILITY: Loss of weight in grinding media after 24 hrs. grinding of Fused Silica, 24-40 Mesh Grain Size	0.74%	0.16%
CONTAMINATION of CHARGE: Increase in weight of above mill charge after 4 hours grinding time	2.20%*	0.00%**
PERFORMANCE: % of above mill charge reduced to pass through 100 mesh screen, 4 hrs. grinding time	30.00%	55.00%

* This increase in weight of the mill charge after grinding represents material ground off the porcelain balls and incorporated as contamination in the mill charge.
** Almost zero, but extremely difficult to measure.

U. S. STONEWARE
Akron 9, Ohio

Similarly, there have been changes in flat wall paints to counteract the increasing use of emulsion type finishes. The latter may be of an alkyd base emulsion or may be of a vinylite type. The emulsion finishes have found extensive use in interior decoration of homes and this has necessitated an improvement in flat wall paints. Such improvements consist of better flow, less angular sheen and better washability with much improved odor during the drying of the paint. Deodorized solvents together with odor maskants are responsible for the better odor and these now compare favorably with those encountered when using the emulsion type of finish.

Raw Materials

CANADIAN raw material manufacturers have made several changes in their methods of processing resulting in improved products. Recently, vacuum distilled fatty acids, as distinct from steam distilled, have been produced on a production scale. Larger quantities of linseed, sunflower and coconut acids will be available to the alkyd manufacturers in the very near future. The vacuum distilled acids are much paler in color than those obtained by steam distillation. Many of the other fatty acids which are used in alkyd manufacturing along with glycerine will be produced in this equipment as the demand for these products develops.

The dry color industry received quite an impetus during the war years. The pigments which had been available from Europe in pre-war days were no longer obtainable. American sources of supply were not always able to meet the demand of Canadian manufacturers, due to allocation for war purposes. Consequently the Canadian manufacturers of pigments increased their tonnage considerably. In order to keep this market in the post-war period, improvements had to be made in the properties of the pigments. A great deal of research work was done with this in mind resulting in improved dry colors of Canadian manufacture together with some which had not been previously made here.

Basic lead sulphate was first manufactured on a commercial scale in Canada in 1949 being announced to the trade in February of that year. Due to the fact that it is lower in price than the locally manufactured carbonate white lead and has a slightly higher bulking value, a better yield can be obtained at a lower cost with no apparent detriment to the finished paint. This pigment is finding its way into many exterior house paints which formerly contained the carbonate white lead.

Chrome yellows and greens were vastly improved in the post-war period. Light fastness was stepped up, yet the pigments had higher tinting strength and cleaner mass tones. The wettability of the pigments was increased resulting in easier grinding. Practically all the chrome pigments now made in Canada are unreduced. Reduced chrome yellows and greens were still in demand during and for a short time after the war. This demand has now decreased so that there are practically none available today. Chrome greens with a bluish tint have been in demand for some time and modifications in manufacture have resulted in new shades of chrome greens to meet this demand.

Iron blues came in for a great deal of attention. The Canadian made blues were poor grinding pigments as a general rule. This is no longer true. The production of soft grinding iron blues, without any loss of tinting strength or cleanliness of the tone, has been quite a noticeable achievement. Similarly the monastral type of blue pigment also received a great deal of attention resulting in a much easier grinding blue. This improvement is accounting for a larger use of monastral type blues.

Molybdate orange pigments manufactured in Canada in the pre-war period had very poor light-fastness. The much greater brilliancy and higher tinting strength of the molybdate oranges warranted some research work to improve the light-fastness of these valuable pigments. Continued research work on the part of the dry color manufacturers has resulted in the production of pigments having light fastness equal to that of the chrome oranges making molybdate orange pigments superior to those available a few years ago.

Equipment used in the paint industry is mostly imported. True, there is some manufactured in Canada but this is mostly of a type made in the U. S. and copied or slightly modified. There have been few new developments in the equipment field which can be truly claimed as Canadian.

A cetrain amount of basic or fundamental research work is being carried out at present in Canada. Some of this may lead to technological advances in paint and varnish industries in the future but it is still too early to say where some of this work will fit in the scheme of things. During the past decade or two Canadian attention has been drawn to the tremendous value of basic research and as this field grows and expands more advances can be expected in industry. Canadian industry is on the threshold of great expansion and should yield many technological advances during the next decade.

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. . . S. AFRICA

(*From page 50*)

Finished Products

ROOF paints are used extensively in South Africa, because 90% of all the houses have corrugated or asbestos roofs. The most popular colors are: green, permanent green, red oxide, bright red, tile and aluminium. The striking point is that due to the use of cheap roof paints, a lot of roofs are in a deplorable state. In addition to ordinary roof paints there are bitumen emulsion roof paints on the market; very cheap and with a limited durability. These are also used together with impregnated fabric to repair leaks and for overlapping ends of corrugated iron sheets. Flat paints are both in the semi-prepared and in the ready mixed form on the market. A big demand exists too for varnish stains (both gloss and flat); knotting bituminous paints and industrial paints for interior use.

Stoep Paint is the natural type of paint, with it the concrete porch and verandah floors are painted. Colours are green, red and black and the paint film is fairly glossy. In addition to stoep paint, stoep polishes in the same colours are much in favour. Distempers are sold extensively in South Africa, both dry and oil bound. The dry distemper is mainly on a glue basis but there seems to be a tendency to switch over to casein. Oil bound distempers are practically all sold in paste form and lately there has been a big improvement in quality in various brands of this product; practically all of them are on emulsion basis. In addition petrifying liquid—a diluted form of the emulsion, is being produced. Traffic paint is much in demand, especially white and yellow. Most brands are on a methylated spirit base, but overseas competition made some manufacturers turn to petrol or xylol paints. Primers follow more or less the normal pattern; for metal, zinc chromate is gaining on red lead. For wood, pink (extended red lead) primers are used, and for plaster and other wall surfaces preparatory liquid (a low pigmented primer sealer) is the normal product. Undercoatings are manufactured to a lesser extent, in white and a limited range of colors to match the top coat. Plastic relief finishes are mostly on a water base, but better products of a different composition are now being locally produced. Linseed oil putty and grey steel sash putty are made locally and there is a big demand for both. Silk screen paints have been developed in the Union, since import control started, and some good qualities are now on the market.

Cellulose and baking finishes, vinyl based coatings and lime washes (both dry and ready mixed) complete more or less this picture of locally manufactured finished paint products.

Manufacture

PAINT and varnish products are manufactured on a lbs./Imperial gallon basis. Liquids are measured in Imperial gallons, solids in lbs. and sold accordingly. Temperature is exclusively measured in degrees Fahrenheit.

STATEMENT OF OWNERSHIP

Statement of the ownership, management, circulation, etc., required by the Act of Congress of August 24, 1912, March 3, 1933 and July 2, 1946, of PAINT and VARNISH PRODUCTION, published monthly at Lancaster, Pa., for October 1, 1950.

State of New York, County of New York.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John Powell, who, having been duly sworn according to law, deposes and says that he is the publisher of PAINT and VARNISH PRODUCTION, and that the following is, to the best of his knowledge and belief a true statement of the ownership, management (and if a daily paper, the circulation), etc. of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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Paint machinery is up to date especially for final grinding purposes (Keenok Unirolls). Ball mills and porcelain balls are manufactured locally and find a still increasing use.

Edge-runners, triple rollers, high speed mixers (Lange) and pug mixers are also used extensively. Most of the imported raw materials are bought under rebate. They must be stored in special stores (Bond Stores) and are open to inspection by the Custom officials. Locally manufactured paint containers come in the usual sizes of 5 gallon, 1 gallon, ½ gallon, ¼ gallon, 1 pt., ½ pt., ¼ pt., ⅛ pt., further 100 and 50 lbs., kegs for putty and paste paints.

Plans are being made for the early manufacture of dual containers for aluminium vehicle and aluminium paste. 1, ½ and ¼ gallon containers have double friction lids and they can be locally lithographed. Raw materials are frequently bought according to British Standard Specifications, which are used throughout England and the Commonwealth. The B.S.S. Colour Card is specified by the South African Railways. To a lesser extent some finished products, varnishes for instance, are also specified to conform to B.S.S. At the moment there is in South Africa an Import Control, but there are indications that the position is now easing somewhat.

Labor in the factories is exclusively Native. Some Indians are also employed and most of them are organized in Communist influenced trade unions. Native labour in South Africa needs constant and careful supervision by responsible European foremen. Frequent errors cannot be avoided and this naturally has its bearing on overheads, quality and uniformity of paint products.

Oil length of varnishes is mostly indicated by the ratio oil to resin, to a lesser extent by the amount of gallons of oil cooked with 100 lbs. of resin. For exterior varnishes and paint mediums this is generally speaking, not lower than 3 oil to 1 resin or 30 to 33 gallons per 100 lbs. of resin.

Terminology is similar to that used in England; varnish, medium or vehicle, binder (non volatile vehicle, protein or emulsion in distemper), lacquer, enamel, enamel paint, varnish stain, scumble stain and scumble glaze, plastic relief finishes and stainers.

My personal opinion is that it would be advisable to create an International Paint Terminology, seeing that in America for instance, the terms used are somewhat different. (dado-, trim-, arellis-, and shelf paint.) The ratio of pigment to binder is mostly indicated by the pigment/binder ratio (sometimes on a weight basis), but also by the pigment-volume ratio, as saturation value has proved to be unsatisfactory.

Application

AT the moment there is quite a lot of building in South Africa, and consequently there is a fair demand for paint products. South Africa has a European population of just over 2 million people. There are comparatively few qualified decorators available, a lot of painters not being fully trained. An unduly small number of apprentices is being trained, the ratio being less than 1: 0, so that the total trained force is not being increased to meet the demand. A great deal of the paint work done is cheap and looks far from beautiful. Most of the qualified painters come from Europe and soon start their own business as a paint-contractor. Colored painters are sometimes found willing to work for 60–75% of the charges made by European decorators. Official bodies like the provincial administrations,

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BLACK EAST INDIA
BATU EAST INDIA
PONTIANAK

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CONGO COPAL
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municipalities and also the railways as a rule maintain a higher level of quality in paint work than private decorators. Price of paint products is an all important factor because the average South African does not want to spend much money on paint work. Therefore, cheap paints find a ready market and the limit between cheap paint and bad paint is not always drawn very judiciously. The decorators have their own ideas about painting, for instance the use of dry distemper as an undercoat and oil bound distemper as a topcoat; the use of flat oil paint as undercoat, the mixing of dry distemper in oil bound distemper, etc. They frequently omit petrifying liquid in the first coat of oil bound distemper; a pink wood primer is made simply by tinting flat white paint with some red enamel. Synthetic enamels and varnishes are often applied too thick or in full sunlight, which results in very pronounced wrinkling. Paint systems generally used are primer and topcoat; undercoatings making it a 3-coat system are not much in favor. Fillers for knife application are not used, whereas knotting is used sparingly; some decorators specialize in lime-spraying and glazing. The biggest towns of the Union, such as Johannesburg, Capetown, and Durban, have many modern skyscrapers, hotels and flatbuildings. As a rule, the paint work of these buildings is simple but of a decent quality. Houses in the suburbs stand far apart and have a floor about 3 feet from the ground to keep vermin out. The style is modern; walls are mostly plastered in white or pale shades, often with some relief. Sloping corrugated iron and asbestos roofs are prevailing, but tile roofs are more and more used; windows are mostly made of steel. The paintwork of these houses leaves much to be desired, probably on account of the sky-high prices (£ 2000–£ 6000), which prevent people from engaging decorators for periodical paint work. Near the center of the towns we find the older type of houses, brick faced with wooden windows, but more often, corrugated iron walls and roofs. The paint work of the latter can be qualified as poor: walls in dull grey, roofs green or red oxide, floors dark varnish-stained. It is quite common to see a native house boy painting the roof of this type of house with a broomlike brush and a poor quality roof paint. Summing up, it must be stated that price is an all important factor, that paint systems are, as a rule, very simple, and that skill and the number of qualified painters can be improved.

Research and Testing

RESEARCH on paints and allied protective surface coatings is being carried out by the *Paint Industries' Research Institute* in Durban and by the *Council of Scientific and Industrial Research*. The Paint Industries' Research Institute issues periodic literature digests and its first bulletin was on "Vinyl Polymers." *The South African Bureau of Standards* in Pretoria has drawn up specifications for various pigments and drying oils. It intends to draw up specifications for finished paint products, but there are indications that a lot of paint people would prefer specifications giving for each type of paint the required properties and behavior rather than a formulation. Moreover, this Bureau tests tenders and deliveries of paints for the Union Defense Force. Some municipalities have laboratories where paints, delivered or tendered for municipal bodies, are tested. *The South African Railways and Harbours* have their own specifications for paint products ranging from paste paints to varnishes, marine paints and coach enamels. In each province they have their inspection centers, but tenders and deliveries are tested in the main

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laboratories in Johannesburg, where also research work is carried out for the development and improvement of their specifications. Since 1948 alkyds have been introduced on a comparatively small scale in their specifications, followed in 1949 by anatase and rutile titanium oxide. It must be said that every year their specifications are becoming more and more up to date. Other technical bodies are the *South African Section of O.C.C.A. (Oil and Colour Chemists Association)*, the *South African Chemical Institute* and the *South African Paint Manufacturers Association*. Partly due to the requirements of the South African Railways, who also specify the instruments for testing their paints, all the larger paint manufacturers are by now equipped with these instruments. For instance for:

Consistency—Krebs modification of the Stormer viscometer

Fineness of Grind—Grind gauge of the New York Paint Club

Hiding power—Morest 04 hiding power charts

Hardness—Sward-rocker apparatus

The Gardner color scale 1933 (1–18) is widely used, the same applies to the Gardner-Holdt values for viscosities, although the use of the unit of absolute viscosity (poise) is increasing. Some time ago, there were proposals made to standardize on type and results of weatherometers.

Production

IN the Union, there are about 75 paint factories, but production, import and export figures are not available as practically none are kept. It is believed that South Africa can produce all its paint requirements, but whether it is in a position to compete with overseas manufacturers is still an open question. As has been said before, there is now an import ban on most paint products and this no doubt will give local manufacturers a chance to prepare for future competition with overseas products. Some of the American paints popular in South Africa are particular brands of road marking paint, flat wall paints, silk screen paint and washable distempers. They combine good qualities with a very competitive landed price and will, therefore, be very hard to beat, should better import possibilities arrive again. Finally, it should be mentioned that it is very difficult, if not impossible, to give any idea as to the direction in which the raw material manufacturers will develop their products. This is mainly due to the fact that practically all of them are most reluctant to disclose even basic ideas about future developments, manufacturing processes and applications of their products.

ADVERTISER'S INDEX

Abbé Engineering Co. 37
Advance Solvents & Chemical Co. 36
American Cyanamid Co. ..... Oct.
American Zinc Sales ..... Oct.

Bakelite Div., Union Carbide & Carbon Corp. 5, 6, 7, 8
Baker & Adamson Products, General Chemical Division, Allied Chemical & Dye Corp. ..... Oct.
The Baker Castor Oil Co. ..... Oct.
Barrett Div., Allied Chemical & Dye Corp. ..... Oct.
Binney & Smith Co. ..... Oct.

Carbide & Carbon Chemicals Div., Union Carbide & Carbon Corp. ..... Sept.
E. W. Colledge, G.S.A., Inc. 58
Commercial Solvents Corp. 59
Concord Mica Corp. 69

The Davies Can Co. ..... Oct.

The English Mica Co. ..... Oct.

Falk & Co. 11, 37

Georgia Kaolin Co. 64
Gillespie-Rogers-Pyatt Co., Inc. 67

W. C. Hardesty Co. 48
Hellige, Inc. 11
Hercules Powder Co. 61

O. G. Innes Corp. 68

Kent Machine Works, Inc. 9

J. M. Lehmann Co., Inc. 4

Magnetic Pigment Div., Columbian Carbon Co. .. 43
McCloskey Varnish Co. ..... Oct.
Metals Disintegrating Co., Inc. ..... Oct.

Newport Industries, Inc. ..... Back Cover
Nuodex Products Co., Inc. 53

Palmer-Shile Co. 11
Pan American Refining Corp., Pan American Chemicals Div. 62
Photovolt Corp. 11

R-B-H Dispersions, Interchemical Corp. 52
Reichhold Chemicals, Inc. ..... 2nd Cover
Rohm & Haas Co., Resinous Products Div. 57
Charles Ross & Son Co. 55

Shell Chemical Co. 38, 39
Shell Oil Co. 42
Sindar Corp. ..... Oct.
Sun Oil Co. ..... Oct.
Synthetic Chemicals, Inc. 66

Titanium Pigment Corp. ..... Oct.

Union Carbide & Carbon Corp., Carbide & Carbon Chemicals Div. ..... Sept.
Bakelite Div. 5, 6, 7, 8
United Carbon Co., Inc. ..... Oct.
U. S. Industrial Chemicals, Inc. ..... 3rd Cover
U. S. Stoneware Co. 65

R. T. Vanderbilt Co. 58
Vegetable Oil Products Co. 31
Velsicol Corp. ..... Sept.

C. K. Williams & Co. 37

G. S. Ziegler & Co. 54

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